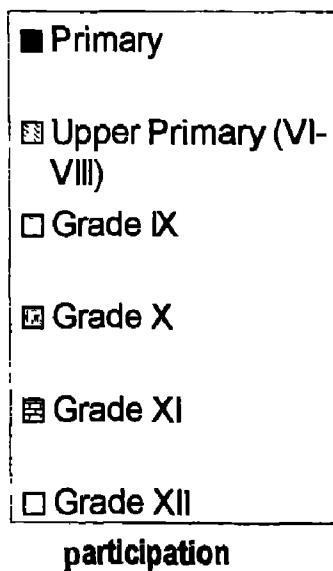
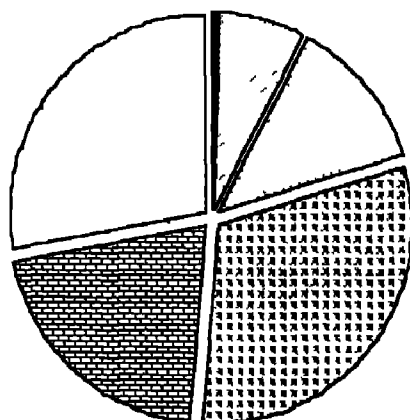


TECHNOLOGY

- as defined by Children

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Technology - as defined by Children

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PREFACE

To the Reader.....

This book is written for School Children. Teachers, managers and activists of Science Popularization and those interested in technological innovations could also benefit from it.

Before going through this book the reader is requested to write down her/his definition of technology at the bottom of this page. Then only the definition of technology given by the children here would be enjoyable.

The term OSA (Out –Of- School) activities in science and technology was coined in early 70s and was recognized by international bodies and the UNESCO. This was a major step for nurturing creativity in the school children who don't have any door to come out of the confines of the curricula.

112 definitions of technology coined by children have been detailed in chapter 1. Though an accepted definition exists, probably there remains scope to modify or add to it, as state of technological innovation today is at its all time peak and non-biological intelligence these days is doubling every year.

Children are creative by nature. Given sufficient freedom they will ask questions which elders sometimes can not answer. For innovation to flow, children should keep on asking questions. The teachers and parents should make a resolution to encourage the child to ask further such questions and give correct answers. There is no loss of prestige if the elder does not have the correct answer. S/he can always go on an information treasure hunt to satisfy the child. Situation will be simpler and regarding if the elder takes the child along in the pursuit of knowledge and s/he is ready to learn from the child. Recommendations for a better S&T environment are implied in sections 1.4 to 1.7.

15 selected technological innovations out of thousands exhibited by the children during last three decades have been given in chapter 2.

'Frontier Science and cutting edge technologies in India' – has been discussed in chapter 4 and STP-2003 (Science & Technology Policy of India) statement has been quoted in the annexure. Suggestions and comments on this book will be welcome.

P.K.Bhattacharyya
11 February, 2003

1. Formal Science Versus Out-Of-School (OSA)

Activities in S&T

1.1 Children and OSA

S&T holds the key to liberation from obscurantism and prejudices. Human civilization has already experienced that a society either adopts technology wholeheartedly or perishes, because S&T is the very base of modern agriculture, industry, transport and communication, health care, entertainment, crime deduction etc. The current phase of ICT revolution has the promise to level the information divides in the society.

S&T education is required both in and out of the classroom. The formal classroom has failed to go beyond a highly structured, rigid, routine drill and written examination orientation. So it has deprived the learner of the pleasure of observation, doing and creating. Out-of-School Activities (O-S-A) in S&T are actually examples of problem solving and critical thinking in areas which require S&T intervention for newer and innovative solutions to old problems bothering the society. These solutions have the key to economic success as well as improvement of quality of life. These activities are displayed in science exhibitions and so, various activities in S&T in its own right should get all encouragement from all quarters for further expansion.

Prior to the first industrial revolution, technological development had been through handicrafts. The third quarter of 20th century has seen the peak of advancement of technology so far. This technology has come to stay with its proliferation in our social culture, economic development and every walk of life whether we are in urban or rural environment. Around the era of first industrial revolution, 'science' started claiming its place in the curriculum for scholastic development. Gradually the society transforms with development of technology; experience of manual work and acquisition of some skill were required for employment. So formal education having technology bias had to be evolved. Modern civilization requires knowledge of technology as a pre-requisite for leading a modest life in today's society. Therefore along with engineers, scientists and technologists the society also needs a population, which will be able to make choice of available technologies and generate demand of technology to solve the emerging needs of the

society Therefore S&T has been made as a compulsory subject up-to class X in the National Curriculum Framework 2000.

Locales for various Out-of –School activities include schools, homes, community centres, clubs, factories, shops, farms, deserts, beaches, forests, seas, lakes any where Science & technology is not merely something, which is learnt, but it is something which is done The international coordination committee ICC defines OSA as “Educational activities undertaking all done outside the formal teaching periods and the formal curriculum and activities is out- of- school even if takes place within the framework in the school even if take places in a free activity period which is normally part of school working day”

The science club programme in India was initiated in 1957-58 and by 1962 about 500 clubs were established with the help of central aids of Rs 1,200/- each , efforts were made to establish science club in about 5% high schools and HS schools of the country By 1966 there were about 910 science clubs In 1965 the NCERT published a book titled *Organizing Science Club* This book highlighted training, motivation, organization of activities etc and listed 83 possible areas for projects Science clubs in America are one of the oldest and largest The project technology movement schools in UK brought out various innovative publications In the erstwhile USSR, *Pioneer Palaces* provided all possible activities for the budding scientists e.g astronomy, astrophysics, astronomical science, biology, sports, space science, rocket technology, etc They used to be a competition “young technologists’ service to the country “once in every two years

Out-of-school S&T activities in India at various levels of school education , as observed generally, may be classified as follows

Primary level – simple experiments, model making, sky observation, demonstrations, quiz, field trips, science exhibition, science drama, etc

Secondary level –wall magazines on S&T, debates, field trips, street plays, science drama, puppetry, use of camera, convergence of media on computer, simple projects and analysis of data, telescope making and use, rocketry, exhibition of new interventions of S&T in making the quality of life better, etc

HS level - circuits with electronic devices, developing computer software, photography, field trips, investigative projects, debates, message on contemporary local problems through science drama, high-end convergence of media on computer, exhibition of frontiers of S&T , etc

1.2 Children having OSA in Science & Technology approach the right definition of *technology*

1.2.1 The Questionnaire

The NCERT has been organizing Jawaharlal Nehru National Science Exhibition for Children (JNNSEC) every year since 1971. The 29th JNNSEC was held at Hyderabad during 26th November – 1st December, 2002. The theme of the Exhibition was **Science and Technology for Society**. Eight sub-themes were given: *Landmark in Science, Harnessing Energy, Food, Environmental Management, Nutrition and Health, Transport and Communication, Science and Technology for Entertainment and Educational Technology*. On this theme there were state level exhibitions. Best exhibits from states were selected for the 29th JNNSEC, the profile of which is given below:

- No. of States/Union Territories 30
- No. of Exhibits presented 227
- International participants (Quatar, Oman, Kuwait, UAE) 10
- No. of participants (Students and Teachers) 454
- No. of boys 158
- No. of girls 69
- The six-day exhibition was visited nearly by one-lakh students, teachers, parents and thousands of science loving public from and around Hyderabad

A questionnaire in the format shown below was distributed among the participating students and teachers. Column 27 (*what is the definition of technology according to your own concept*) was responded by 112 children

Ten questions (nos 1 to 10) in the questionnaire are about the personal details of the child. Next ten questions (nos 11 to 20) are about idea and fabrication of the exhibit. Four questions (nos 21-25) are about the exposure of the child to Science and Technology through print, non-print and cyber media. Two questions are on real life problems in the immediate environment of the child requiring intervention of Science and Technology and **definition of Technology** according to child's own concept. The last question was on comments on the whole.

Teachers were asked six questions: three questions on their exposure to science popularization movement in India. Two questions were asked on their exposure to science through print, non-print and cyber media. Three comments from the teacher were invited on the statements made by the student.

It was interesting to note that most teachers are not aware of the Science Centres of the National Council of Science Museum (NCSM) dotted over the map of India as well as the activities and publications of Vigyan Prasar/National Council of Science Technology Communication (NCSTC) of Department of Science and Technology (DST). In general, the teacher has hardly reacted on or amplified the definition of Technology given by the student and it is very inspiring to note that the students have a deeper understanding of technology. Though sometimes they starved of appropriate language but they showed all enthusiasm to express themselves. Detailed analysis has been given at 1.2 and 1.3.

QUESTIONNAIRE

This has two parts (A) for Students (B) for Teachers

A. For Students

- 1 Title of the Exhibit at the JNNSE-2002
- 2 Name of the Student
- 3 Age 4 Sex Female/Male 5 Class
- 6 Stream (Science, Arts, Commerce etc) 7 School Govt /Non-Govt
- 8 Address of School (*mention name of the state*)
- 9 Whether the area is Rural/Semi Urban/Urban
- 10 Occupation of your father Mother
- 11 Where did you get the idea of your project from Your teacher/parents/books/others
- 12 Who guided you to give shape to your ideas?
- 13 Who guided you to write- Introduction, Principle, Working, Construction etc
- 14 How many days did you take to prepare the model?
- 15 Who helped you in fabricating your model?
- 16 List main tools and materials used in fabricating the exhibit
- 17 List the problems you faced in fabricating /preparing the model/exhibit
- 18 Did you participate in any Science Exhibition earlier Yes No
- 19 If yes, mention -Names of exhibition with year(s)
-Venue, -Title of Exhibition
- 20 Title(s) of your exhibits
- 21 Do you read Science magazines/journals Yes No Mention names
- 22 Name the Science Center(s), Planetarium, etc in your Dist /State Mention number of visits
- 23 Do you have access to Internet Yes No If yes, mention your favorite sites
- 24 List the programmes you listen over radio How many hours per week?
- 25 List the programmes you view on TV How many hours per week?
- 26 Has your locality any problem to be solved by Science and Technology? (*Write 4 sentences*)
- 27 What is 'Technology' according to your own concept? (*Write 4 sentences*)
- 28 Any statement you want to make on (a) any aspect(s) not mentioned above, (b) popularization of Science & Technology among School children (c) improvement of organization, participation and, quality of exhibits (*attach one separate sheet for writing details of sr.nos 16,17,21 to 28*)

Signature of the
student with date

B. For Teachers

I Name

II Sex Male / Female

III Qualification

IV Teaching Experience

V Hours of Science Teaching per week

VI Teaching classes V /VI /VII /VIII /IX /X /XI /XII

VII Mention the names of Organizations in India responsible for popularization of Science

VIII Which are the Science Centre, Museum, Planetarium, Industry, Laboratory, etc, in your Dist /State? How many visits the students made to them during the last 3 years?

IX List Science Club facilities your school extends to students

X List Science Magazines and Journals you read and recommend to your students, name the article read by you last

XI List TV and radio programmes on Science you will recommend for 'must' viewing/listening

XII Give comments on the statements made by your student prepage, particularly on those at serial nos.16, 17,26

XIII Give comments on the amplification on 'Technology' made by your student at Sr.No 27

XIV Please give your expert comments on Sr.no 28 prepage (you may use a separate sheet)

-Signature of the Teacher with date

1.2 Children contribute 112 definitions

Out of 115 responses received from the children , 3 have been set aside as they are incomplete. The definitions are reproduced below after touching upon minor grammatical and spelling mistakes. Below each definition, the *Sl. No , Name, Age, Grade, Name of School, Address of School, Occupation of Father* have been mentioned

- Technology is scientific development in the modern world in the field of

Agriculture, Industry, Transport, Communication and other fields

– 1 Kamarajan,14, IXth,T T VI KA Govt High school, Pondicherry, Auto Driver

- 'Technology' – means use of scientific principles and manpower for need and development of mankind

– 2. Mangal Singh, 17, XIIth (Science), Kendriya Vidyalaya No 1, Amritsar Cantt, Punjab, Railway Protection Force (R P F)

- According to my own concept Technology is a way by which we walk to Science
Technology is path to science Technology has changed the human history It has sent us to

moon, mars and far above We should spread technology with the help of Radio, TV Programme and CD etc.

– 3. Faizan, 14, VIIIth, Kendriya Vidyalaya, Gonda – 271 002, (U P), Service

□ Technology means to use science theory practically

– 4. Grace Rai, 16, XI, Mangan Sr Sec School, Mangan, N. Sikkim, Teacher

□ According to my concept I feel technology is such a science by which we can solve our day today life by simple technique and also we can be capable to enjoy the world by the help of science and make life easier.

– 5. Sonali Dhur, 7+, III, Binapani Vidyaniketan, Orissa, Teacher

□ To put science and scientific principle into application which can be used for the betterment of society or mankind

– 6. Mr Jagmeet Singh, 18, Govt Sr Sec School, Sector-27c, Chandigarh, employee

□ Technology means implementation of different aspects of science like experiments and theory practically

– 7. Puja Pradhan, 18, Chuyachen Sr Sec School, P O Rongh, East Sikkim, Teacher

□ Doing things accurately, profitably, convenient by and on basis of eco-friendly procedure

– 8. Yash Pal, 16, X, Maharana Pratap Public School, Kurukshetra. Sales Manager

□ Science is a technique, which makes our life secured and comfortable

– 9. Rahul Tiwari, 17, XII, Govt Hr Sec School Gondbahal, Teacher

□ Technology is an art to use the scientific discoveries in daily life of human and to build up our society

– 10. Rupinder Singh, 16, X, Shri Guru Harkrishan Public School, Bhatinda, Pb, Service

□ Technology is application of scientific principles.

– 11. Bhadrash H Patel, 16, X, Non-Govt, Gujarat, Dairy Business

□ In my view “Technology” means proper understanding of our surroundings and then to find solutions faced by our society, our nations, our country and the universe in which we live

– 12. Jahangir Ahmed Mir, 18, XII, Govt Hr Sec School, Kralpora Kapwara, J&K, Accounts Assistant

□ A new scientific idea to reduce energy or save something

– 13. Riyas P M, 15, X, Kerala Agriculture University School, Kerala, Govt Employee

□ It is the process of implementing principles for useable purposes

– 14. Amarjit, 15, IX, Govt. Sr. Sec. School, Sector 27-C, Chandigarh, Died

□ Converting Non-resource in resource is known as technology

– 15. Tanveer Nisar, 15, IX, Muslim Model Educational Trust, Pulwama (J&K), Orphan

□ Technology is the science adopted to design the devices for better comfortability of life.

- 16. M Shruthi, 15, X, Mycem Composite P.U. College, Karnataka, Dy. Manager Engg Mysore Cements Ltd.
Father
- Technology is scientific method
 - 17. Sanjit Bhattacharya, 17, XII, Kamalpur Madrasa Class XII School, Govt Service
- To improve the economic, social and culture ideas
 - 18. Geetu Sharma, 13, IX, International Hr Sec School, Rajouri (J&K), Teacher
- Technology is an “Innovative Idea”
 - 19. Meenakshi N, 14, IX, K S M H School, Chenchupet, Tneali, A.P , Teacher
- Technology is science We are applying this technology in various section especially in living things
 - 20. Sudha Rani, IPWC PCNB, Kalidasa PW College, Karnataka, Driver
- Technology is the process in which we can develop our life
 - 21. Arvind, 16, +1, G M H School, Sector 41, Chandigarh, Govt Service
- Application of Science to solve human problems is known as technology
 - 22. Vivek Chandy Alexander, 15, X, A.K J M H S School, Kerala, Civil Contractor
- Which can be useful to maximum number of people, with least possible disadvantages
Some tech which does not cause pollution + does not pollute environment
 - 23. Rutuy Kotecha, 18, XII, Not given, Safety Engineer
- It is the practical use of modern science used to serve mankind Its main use is communication, e g to communicate through Internet or phone etc we need technology
 - 24. Aryana Chandrasekaras, 12, VII, Modern Indian School (Delhi Public Sch) Doha, Satar. C A
- Technology is development of logical idea
 - 25. Patel Umesh P . 20, XII, Anklav High School Anand, Rajasthan, Farmer
- Technology is a new idea and applied science
 - 26. Bhalkama Chetna, 14, IX, Sh Uttar Bunyadi Kanyavidyalaya, Gujarat, Teacher
- According to me technology is stronger way of solving any type of problem Due to technology today we are roaming with comfort Due to technology today we are able to communicate with each other easily
 - 27. Ravi Singh, 14, X, St Paul’s School Sasaram, Bihar. Business
- Technology means in my concept to make coherence with the communities lying in our surroundings in the public welfare
 - 28. Mohd. Faisal Danush, 13, X, M S Inter College, Bulandshahr, U P , Teaching

- Technology. Use of new and innovative ideas for the development of science is technology. It is considered to be one fundamental aspect for the development of a nation Technology also provides both economic and military security for a country

– 29. Chandan Misra, 17, XII, D M. School, R.I E , Bhubneshwar, Lecturer

- Development of technology is called technology concept

– 30. M Rama Samhitha, 14, X, St Mary's Girls High School, Andhra Pradesh, Business

- Technology means to develop a thing by the help of various inventions and components of science which is useful for the various people, various technologies have been developed and various are yet in developing phase We the junior ones should be encouraged at different stages from the rural areas so that new talents can come up and make their country better

– 31. Mohit Kumar, 14, X, Nave Institute Inter College, Lodhipur, Shajahanpur, U P ,Service

- A technology, which make human best and other creature's life easier

– 32. Meena Kumari Subba, 15, X, Govt Sec School and Samiti, Sikkim , Teacher

- Technology is an idea to improvise the theory and experiments

– 33. Deepak Lodha, 17, XII, Govt Hr Sec School Senth, Chittor, Business

- Contribution of science in industry

– 34. Daman Preet Singh,18,Class + 2 , ,Govt Employee

- Technology is a process in which new scientific projects, models are prepared on the basis of new concept

– 35. Tannu Gupta,15 ,X,Ghanshyam Balika High School, Khagaul, Patna (Bihar), Ex-service

- To go through any problem and to get the data about them The data should be analysed to get some idea The Scientists and Technologists are to judge how far it will help the society If it cannot, it is rejected otherwise it will be accepted This is called technology

– 36. S Saikrishna, 14,IX, Police High School, Orissa, Business

- Technology is the key to making a better life

– 37. Arun Bapderi, 16, XI, Govt Sr Sec School, Diglipur, North Aandamak, Business

- According to me technology is that field of science which enables us to know about techniques behind different projects and scientific appliances It facilitates us to know about the working techniques, scientific principles used and its uses facilitate, the welfare of society

– 38. Shupra Khare, 15, XI, Narayani Kanya High School, Patna, Private

- Technology is most important present day. With help of technology we send the messages in no time and we can communicate the news all over the world

– 39. K. Prathima, 15, X, Vijay High School, Nizamabad, A.P ,Protection Manager

– 40. P. Spandana, 12, VII, St Theresas Girls High School, Eluru, Distt W G , A.P.,Farmer

- Application of basic science in daily life is technique of science Science technique to make life comfortable are yet to reach villages lack of opportunity for the individual is also the greatest problem and this problem has to be solved first

– 41. Sahuh Navso Kalangutkar, 17, XII, Govt Hr Sec School, Goa, Meason/Painter

- Conversion of non-resource into resource

– 42. Anju Bhardwaj, 17, XII, D A.V ACC Sr Sec Public School, Barmana, H P , Employee – ACC

– 43. Laly, 17, XI, Govt Girls Hr Sec School, J & K,Business

- Technology is the application of applied science for technical growth

– 44. Gurjeet Singh Gill, 18,XII,Bhupendra Khalsa Sr Sec School, Punjab,Doctor

According to me, Technology is the practical application of scientific knowledge to make the life of all easier It deals with ever- widening efforts on research and improvement Thus, technology is the consolidation of all the available facts to formulate the methodology of finding solution to problems Technology should not exclusively deal with gadgets

45. Deependra Hamal, 16, XII, Tashi Namgyal Academy, P O Raj Bhavan, Gangtok, Sikkim,Doctor

- Technology is use of scientific principles and apparatus in the service of human life Today it is impossible to live without scientific aids So we have to develop technology

– 46. Arun Kumar, 18,XII, G C I C Mussoomic Uttranchal,

- Solve the problems of human being

– 47. Toshendra Sharma, 13,X, H N Inter College Haldwani, Nainital, Uttranchal,Business

- Technology means advancements in the field of human life which helps the human to a better & respectful life and technology, has never-ending things with each advancement, technology expands

– 48. Ajay Kumar Verma, 14, IX, Govt Model High School, Sec- 43 A, Chandigarh,Business

- The term in itself has a wide connotation in my opinion, it means a channel of continuous tapping of human knowledge & creativity to work wonders to make this world a better place to live in

– 49. Priyanka Gupta, 15,XI, Montfort School, Ashok Vihar, Delhi- 110052,Doctor

- Technology is a way of advancing and harnessing our scientific knowledge Due to this we can shape our ideas

– 50. Sanjit, 16,XI, Mamta Modern School, H Block, Vikas Puri, Delhi- 18,Sales Officer, Asian Paints

- According to me Technology is a mode to convert human life.

– 51. Pankaj Sharma,17,XII,S B B.M Sarvodaya Vidhayalaya, Delhi,Service

- Technology is the development of new technique based upon science mainly required to develop the standard of our society Technology is the branch of science which deals with

the study of new experiment, inventions, tools, chemicals, etc only to raise the standard of life It's the implementation of scientific knowledge in agriculture, medicine, Industries etc

– 52. Navneet Singh Manhas, 15,XI, K.V.J Chandi-Mandir (Haryana), Army Man

- Technology, according to my own concept is improvement in science and applications of new techniques by using scientific knowledge

– 53. Rita Khaval, 16,XI, K V Ashoknagar, Chennai –78,Executive Officer

- Technology is improvement in science According to my concept technology is the need thing of the era.

– 54. Gautham A.C, 17,XII, JawaharNavodaya Vidhyalaya , Karnataka,District Manager

- Technology is the new advancement in science developed by us to solve the problem in new & good manner with more efficiency

– 55. Ankit Vora, 15,XI, Atomic Energy Central School, Indore, (MP), Scientist

- Implementation of Scientific means

– 56. Lashanbor Lyngdoh Nongpiur (H.I.), ,IX, School and Centre for the Hearing Handicapped Children,Laitumkhrah, Shillong, Meghalaya Business

- Technology gives an idea regarding new scientific developments

– 57. Bhumika Ray Mohapatra, 12,VIII, A G High School, Orissa, (Sunabeda), HAL Employee

- Technology means implementation of scientific theories by technical means

– 58. Anjit Bhattacharjee,16,X, Udaipur English Medium HS School, Tripura (S), Govt Contractor

- We have Vivekanand Agriculture Laboratory in Almora It had improved our agriculture methods Science and Technology brings a very good revolution in our daily life style

– 59. Govind Singh, 18,XIIth, Almora Inter College, Almora – (01) Usttranchal. Service

- The process of improving scientific awareness is known as technology

– 60. Vinsfy Joseph, 14, IX, K V Bijapur, Afzalpur Takke, Karnataka, Business

- It is the development of science It is one of the forms of science It is related to science

–61. Pratiksha, 14,X, ,Reader

- Mobilisation of different ideas to develop revolutionary concepts

– 62. T B Bopanna, 16,XI, Demonstration School, RIE, Mysore, Karnataka, Coffee Planter

- Technology is the attainable knowledge of science for development of people and the community I think science is always related to technology Technology is also a dependable knowledge

– 63. P M Priyas, 15,X, Demonstration School, RIE, Mysore ,Asstt General Manager

- Technology means improvement of development in science Hence, in my spinion technology plays an important role in the life of citizen.

– 64. M S. Sbuhas ,13 ,IX,Demonstration School, RIE, Mysore ,Teacher (School)

- Technology is the science of techniques, which can make man's way of living comfortable and increase the quality of living

– 65. A.S. Ganesh Ehuthamlalam, 17,XII, P.E.S.R.S N. Hr. Sec School, Goa. , Private

- Application of scientific principles in machines to make the life easier It is applied in various fields such as agriculture, transport and communications, medicines, defence, entertainment etc

– 66. Rostiful Marngar, 13, VIII, St Peter's H S S. Pynderganj, Meghalaya, Govt Employee

- According to me technology is a process through which one can change his living style and make it better and comfortable It is through this technique his country can progress and be in competition with advanced countries

– 67. Anand Anubhav, 18,XII, Govt Boys Sr Sec School, New Delhi , Expired

- Ideas put into practice is technology

– 68. Tanya James, 15, X, Presentation High School, Kerala , Farmer

- Technology gives better life

– 69. Suhana Mehon M, 15, X, PPMHSS Kottukkara, Malappuram(Distt), Kerala ,Teacher

- Technology means a way of getting easy method of living

– 70. Babitha, 16,XI, Govt. P U College, Karnataka, Clerk

- Technology is a branch of science which proves helpful in all the fields of communication, defense, medical, etc If it is misused it also brings destruction to the humanity We should use technology wisely

– 71. Miss Pooja Rajak, 18, 12, Govt Hr Sec School, Jammu (J & K), Business

- Technology is according to me a boon to human life Today life without technology is unimaginable cell phones, computers, the internet are all examples of technological advances

– 72. Shrey Bhardwaj, 15,XI, K V ONGC, Dehradun, Uttranchal, Service (ONGC)

- Technology is a part of science, which helps in development of society in many aspects

– 73. Debi Dutta Das, ,XII, D.M School, RIE, Bhubaneswar ,Service

- It is the knowledge, which not only provides luxury but also harnesses nature

– 74. Debahis Mallick, 17, XII, D M. School, RIE, Bhubneswar, Govt Servant

- Technology is that part of science, which deals with the development of human society through innovative idea Modern and sophisticated ideas take the shape of technology when it is used for the betterment of society It is most vital in this modern world

– 75. Manish Mishra, 16,XII, D.M School, RIE, Bhubneswar, Associate Professor

- Technology is a branch of science that came to our knowledge with the progress of human civilization. It's the perception, which enables man to preserve nature and make the maximum utilization of available resources for the all round development and welfare of human race. Technology aims at reducing human labour by giving a wide platform for the interface of mechanical gadgets in human life
 - 76. Kalyani Panigrahi, 16,XI, D M School, RIE, Bhubneswar, Govt Employee
- Technology is a part of science which helps in the development of human society. It gives rise to new innovative ideas which help to solve human problems.
 - 77. Sanjibani Panigrahi, 16,XII, D M School, RIE, Bhubneswar, Service
- Technology is the wise use of our scientific principles for development of our society.
 - 78. Asha Antony, 15,X, Holy Angles Convent School Vanchiyoar, Trivendrum, Bank employee
- Technology is connected to the discoveries in science. The modern science is very good and technology is also good because science is connected to technology
 - 79. Deshpande Nitin Shsikrishnarao, 15,X, Netaji Mandan Beed, Maharashtra, Electrical Chorgeman
- Technology in my point of view is that which will improve the social, economic, political conditions of people
 - 80. V Vignesh, 15,X, K V, No 1, OFI Tricky-16, Tamilnadu, Sub Divisional Engineer, BSNL
- Technology is electro wave theory, current theory, induction theory, detection theory etc
 - 81. Pawan Kumar Mehta, 16,XI, Ramgarhua Sr Sec School, Muller, Ludhryana, Punjab, Service
- Technology is applied science. Science provides the basis, the laws, the principle etc and technology puts it into the practice. Science and technology are inter related without technology science would never develop
 - 82. G Purshotham, 15,X, A.P SW R School, Farmer
- According to my concept if technology is a boon it should be used only for the usefulness of society and community
 - 83. M Abhiram charan Ji, 14,IX, St Joseph High School, Karnataka, A P, Service
- Technology means to do something using scientific principle
 - 84. Anupama Mohanta, 15,X, Dantiamuhan Higher Sec School, Orissa, Service
- Technology is that which uses physics and physical principle and puts them into the practice in the different spheres of science such as biology, chemistry and physics to make life simpler and precise
 - 85. Lionel C D'silva, 15,XI, K V Ins Mandvi, Verem, Goa, Retd. Service man
- Technology means solutions of problem by science
 - 86. Divya Jain, 16,XII, Tiratnba K School, Indore, M.P, Geologist
- Technology is use of science

- 87. Sutuni Sundeep, 16,XI, Suraswati Vidhyalaya, Farmer
- Without technology there is no development Technology means application of science
- 88. D Bharat Bhushan, 15,X, Rotary Eng. Medum School, A.P, Teacher
- It is science by which we can lead our life more easily and with comfort
- 89. Ashutosh Bhuyan, 14,X, Govt High School, Kakatpur, Puri, Orrissa, Teacher
- It is the appropriate scientific concept
- 90. Arvind Guru, 17,XII, Punjab, Doctor
- With the help of technology we can live comfortable luxurious life
- 91. Patel Tejas Jagdishbhai, 15,XI, G H S S. Silvassa, Dadra & Nagar Haveli, Deputy Engineer
- Popularization of science and technology, Govt should provide modern facilities like science conference, laboratory, and science articles.
- 92. Roshni Gupta, XI, Foshuting West Sikkim, Teacher
- Technology helps people to solve their problems and raise the standard of living of our society
- 93. Ku Purnima Sahu, 18,XII, Motitabela, Indore (MP), Service
- It is a science by which a person's life becomes more comfortable
- 94. Satyabanta Bai, 14,IX, Dasarathpur High School, PO- Dasarathpur, Jaipur, Govt Servant
- Technology is having new ideas which when put to use will be useful for the society
- 95. Gouri Rao, 15,XI, Atomic Energy Junior College, Anushaktinagar, Mumbai, Scientist
- Use of principle of science in solving practical problems
- 96. Chirag Chudasama, 15,X, Gujarat, Business
- A tool of development to understand or to utilize to make life easier and safe in this fast growing period
- 97. K S. Jyothsna, 15,X, Gurajada Public School, A P, Teacher
- Technology is development of new methods for meeting the need of people for the progress of their livelihood, such as gathering information through communication technology, transportation through most advanced system like train, biochemical facilities, enhancement of agricultural products, etc
- 98. T.J Sumana, X, Railway High School, Telephone Sup
- Technology means modern technique
- 99. Dhaval A. Vaccham, 16,X, Gyan Jyoti High School, Kalawad road, Rajkot, Gujarat, Business
- Technology is a science We are applying this technology in various sections especially in Biotechnology
- 100. Nithun, 15,X, Kalidasa P U College. Sira Gate, Karnataka, Farmer
- Technology means the scientific method, which modify human life

- 101. Namit Gehlotm, 17,XII, Rajeev Gandhi Memorial Public School, Jodhpur, Rajasthan,Engineer
- Technology to me is the solution of a problem after experimentation, making life easier
Technology comes out with better ways of waste management and planning a better future
- 102. Neha Puri, 17,XII, Oxford Sr Sec School, Vikaspuri, New Delhi-18, Technical Officer in DRDO (SSPL)
- According to me technology is just the application of various scientific principles for a better society
- 103. Akshay Rajagopal iyer, 15,XI, K V Mankhurd, B-Campus, Mumbai,Business Development Manager
- To increase the new source of energy
- 104. Maninder Singh, 18,XII, J N V Khurthal Alwar, Rajasthan, Truck Driver
- Technology is development in science Technology improves the quality of life Technology improves human health and makes life comfortable
- 105. T Yamini, 14,IX, J N V Guntur, A.P .Farmer
- The fundamental Science of today is the technology of tommorow
- 106. G S Kiran, 15,X, Andhra Pradesh,Accounts Officer
- Technology is the thing by which we can make our daily life comfortable on scientific base
- 107. Mitali Vijaysingh Rathod, 14,X, Govt High School Sivassa, Dadra and Nagar Haveli .Teacher
- The process, which help to improve the standard of living of man and to control the population It must help to increase the yield from land
- 108. Deshmukh Pravin Uttam Rao, 17,XI, K R T High School, Mohadi, Nashik, Maharashtra,Wireman
- Technology is the branch of science, which studies the use of science tools
- 109. B C Zodinpuii, 14,IX, Mizoram, Business
- Technology is a science application
- 110. Lalmalsawmi Pachnan, 15,X, Govt Republic Hr Sec School, Mizoram,Govt Servant
- A branch of science in which we use natural resources in a good manner for serving life is known as technology For example in our locality to improve economical condition of farmers by food processing
- 111. Anurag Kumar, 15,X, Raj K K High School, Narepur, Begusarai, Bihar,Cultivation
- According to my concept technology is a tool, which can be used for the development of the society
- 112. Ms Barasha Knwar, ,X, Little Flower School, Meghalaya, Govt Servant
- The word technology means that science which deals with the modern need.
- 113. Dependra Singh, 16,X, Demonstration School Ajmer, Rajasthan,

- Science and technology means advancement, improvement, and revolution in our lives.

– 114. Amit Kumar Kaushal, 17,XII, Karnataka, Engineer

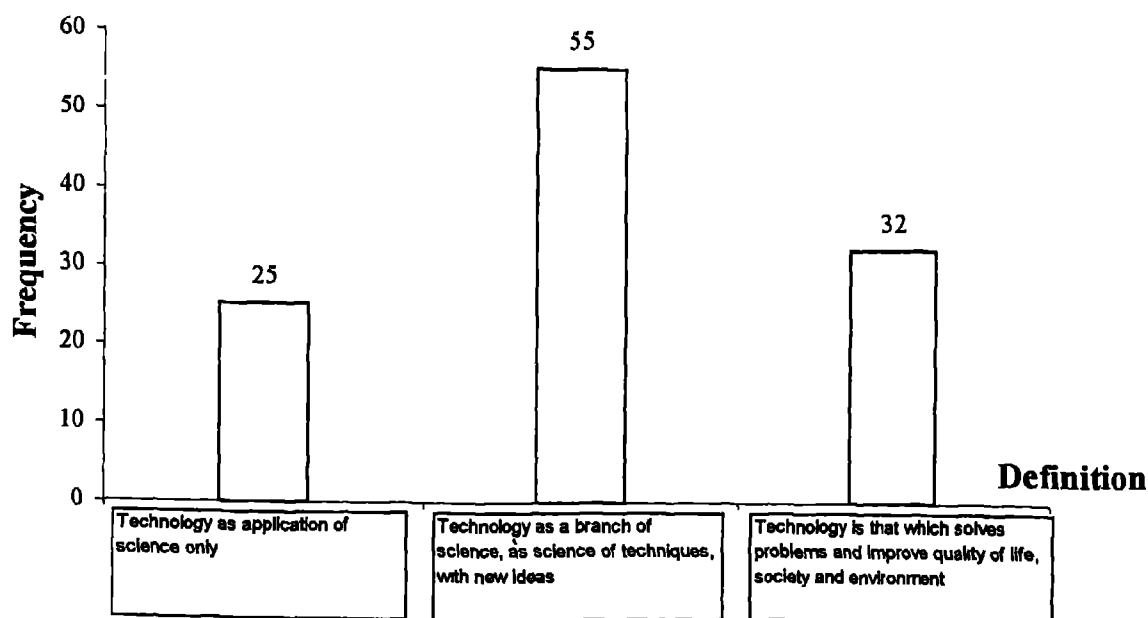
- Technology should be a way to improve life-style of people and affordable for everyone
Technology is something, which every person has to and will imbibe within himself for a fruitful living

– 115. Balaji S Bhardwaj, 16,XI, Demonstration School, RIE, Mysore-570006, Advocate

As the children were given freedom to define *technology* in their own words, they have come out with the expression as they have observed in their immediate environment and as they have experienced in daily life outside the classroom. A closer look in the definitions given by them reveals three distinct components.

- Technology as application of Science only
- Technology as a branch of Science, as science of techniques, with new ideas
- Technology is that which solves problems and improve quality of life, society and environment

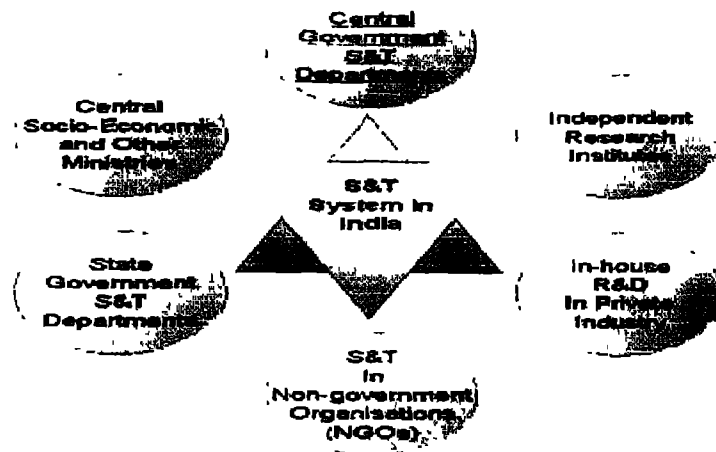
The frequency of these 3 components is shown here -



1.3 Accepted Definition of Technology

These three components in the definitions given by the students, most interestingly, match with the internationally accepted the definition of technology given by Gebhart et al (1979), who after studying more than 100 definitions of technology, suggested that

Technology is the know-how and creative process that may utilize tools, resources and systems to solve problems to enhance control over the natural and man-made environment in an endeavor to improve human conditions.



Source- DST

Today many interpret technology as computers and communication. Such product-oriented perspective of technology ignores the enormous impact it has on civilization and economy. So use of the term *technology* should not trivialize its meaning and should not promote a serious misconception. Computer is the descendent of abacus and calculating machine but *technology* is a field of study. Several basic elements are associated with the definition of *technology*.

Subject linkage

- Technology is directly related to, and often derives from fields of study like mathematics, science, language, arts, social sciences, etc
- Technology encompasses many disciplines i.e. information processing technologies, energy control technologies, material processing technologies, biotechnologies, etc

Technology is not applied science, though science is the cornerstone of technology

- The products of quality are both the hardware and software. These are devices, systems, processes, and environments
- Problem solving and critical thinking trigger creative thought for innovating technology
- Technological knowledge grows at an exponential rate
- The products of quality are both the hardware and software. These are devices, systems, processes, and environments
- Technology can be bought or sold like any other commodity

Subject linkage

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Technology is not applied science ,though science is the cornerstone of technology

- c) The products of quality are both the hardware and software. These are devices systems, processes, and environments.
- d) Problem solving and critical thinking trigger creative thought for innovating technology.
- e) Technological knowledge grows at an exponential rate.
- f) The products of quality are both the hardware and software. These are devices systems, processes, and environments
- g) Technology can be bought or sold like any other commodity.
- h) Technological action requires many types of resources e.g. human resource, information/knowledge, materials, tools, systems, energy, capital, time.

Human dimensions

- i) "Technology is applied human knowledge"
- j) Technology is an innate human endeavour.
- k) Technology is the use of tools and processes to make all lives better.
- l) Because of the presence of an interactive and dynamic relationship between humans and technology, technology is a powerful social force.
- m) Technology produces intended results; it also sometimes produces unintended impacts to individual, societies, and the environment.
- n) Problem solving, and critical thinking trigger creative thought for innovating technology.
- o) Technological knowledge grows at an exponential rate.
- p) Technology is not applied science; humans invented and used technology for survival long before scientific laws were discovered and practiced. As a human enterprise technology has its own history and identity, quite apart from those of science and mathematics.

1.4 Profiles of participating students and teachers

As evident from (Fig .A-I) there was almost equal representation of children from urban as well as semi-urban & rural areas.

As the influence of the parents on children in formative years has to be taken in account, it was found that fathers of the majority are in service (66%). 21% are self-employed. 10% are in agriculture; this reveals that the society has already walked away from agrarian culture (Fig. A-II).

Fig. A- III shows the central role of the teacher in generating exhibit ideas. I in 17% cases the parents give the ideas while in 4% cases the ideas are generated by the child, while in 78% cases the teachers give the ideas. This fixes the onus of the teacher for taking up initiative and for promoting innovative ideas of the child. Fig.A- IV again confirms the role of the teachers in this endeavour particularly for giving guidance to the children in translating design ideas into shape.

Fig.A-V shows that in 72% cases the fabrication of the exhibit was executed in one month. This may be true for electronic circuits, the design of which is available in books and the child with the

help of a professional has to solder. But it might not be possible to fabricate *working* models with moving parts giving desired results, the fabrication of which involves machining, fitting, welding, painting, etc. *in one month* particularly when Science Club facilities in the school are absent in 87% cases as shown in figure B-VI. This factor is also linked with the school level of the participants as shown in Fig. A-XI where it is seen that 31% of children at grade 10 and 28% at grade 12 have participated in the exhibition. We know that grade 10 and grade 12 students hardly have time for O-S-A activities as they have to prepare for the board examinations, the result of which determines their future and as such their parents and teachers discourage them to do anything outside the preparation for the board examinations. So it might be correct to presume that the student preparing for the board examination as well as for the science exhibition simultaneously might have exceptional flare for S&T innovations and /or might be getting all out support from local experts and technicians for fabricating an exhibit professionally.

That the same student with the same exhibit is not invited to the JNNSEC is apparent from Fig. A-VI which shows that only 3% has previous record of participation in the previous JNNSECs.

As per exposure to Science & Technology beyond curriculum through print and electronic media, there is a lot of scope for the parents and teachers to make media available to them extensively. Fig. A-VII shows that 84% of students state that they read science journals. But at the same time most of them could not give the names of the journals they read as asked at column 21. As per Fig. A-VIII, 51% have said that they don't listen to radio programme in science and 40% have said 'yes' to it. While in case of viewing television, 84% view TV and 16% do not. Keeping general programmes in mind and not particularly science programmes, the viewing pattern confirms that the TV is more popular than the radio. Though penetration of Radio in the country is more than that of TV, the situation demands that there should be more episodes on science and technology on the radio as well as on the television. And such programme schedules should be made known to schools and children through generous publicity. Schools compulsorily should have TV, Radio, educational video and audio programmes, computers with Internet, narrow casting and projection facilities. There should be suitable slots in school time-table for viewing audio and video programmes.

To the question "has your locality any problem to be solved by science and technology" most of the children have not even responded (Fig. A-X), some have mentioned problems like water shortage in the school, some have responded by saying "no problem". The teacher could also not go into depth of this question. This question was framed with the intention of linking S & T with society. Hopefully future science exhibitions will incorporate this dimension of S & T.

Fig. A-XI shows the school levels of the participating children. The 29 JNNSEC was participated mostly by the students of grade X (31%) and grade XI (28%); participation of the lower primary and upper primary children stood at 1% and 7% respectively. As the exhibits are selected from amongst those exhibited at the state level exhibitions, it is obvious that the participants now at grade XII might have prepared the exhibits when they were in class X or XI and those at grade X might have prepared the exhibits when they were in IX or VIII. All of us know that students at grades X & XII who have to prepare rigorously for board examinations cannot afford to spend time in preparation of exhibits for the science exhibition. Therefore, in most cases **grades VIII & IX and particularly grade IX is the nursery of such innovative OSA**. The parents and teachers should give intense guidance to children at grade IX level to generate ideas and give shape to these ideas in the form of exhibits for participation in the science exhibitions.

The teachers who accompany the participating children to the science exhibition are mostly males (71%) and obviously with background of science (84%) as apparent from Figs B-I & B-II. The school should send science teachers only along with the children.

Most of the teachers (71%) had more than 10 years of teaching experience (Fig. B-III).

74% of teachers don't read S&T journals and magazines (Fig. B-IV). As we know that the reading habit of the teacher, among others, is reflected in the mannerism of the student who draws all inspiration from the teacher. Therefore, the school should subscribe to all leading S&T magazines meant for school children, collect and compile clipping of all S&T articles published in dailies. For dissemination of such information, the wall magazine of the school will prove very useful. In the midst of explosion of S&T innovations these days, the teacher and children can not afford to be deprived of information on those.

Children also draw inspiration from science museums, science centers, planetaria, aquaria, etc. Even the remotest area in the country will be in the catchment of any one or more of the 28 science centres of the NCSM (National Council of Science Museums), Planetaria, centers affiliated with NCSTC (National Council for Science and Technology Communication), similar centers set up by the state government or private bodies. From the responses of the teachers it is clear that they are not aware of the organizations in India responsible for popularization of science and technology, though 63% of participating teachers say that they visit science museums with students.

Many outstanding working models are found in the Science Exhibition. One becomes curious to know how such professional fabrication is possible when 87% of participating schools don't have in-house science club facilities (Fig.B-VI). So one can presume that the working models are fabricated by the student and/or his teacher and parent outside the school taking help of local technicians. While involvement of local trade experts is also very important, the school need to formalize the same after mandatorily making in-house science club facilities available to the students. Through this process one can expect vast collection of innovative ideas and distinct improvement in the working models.

A. Survey on Students

Fig. I : Rural - Urban

Urban	97
Rural	48
Semi-urban	25

Fig. : I Rural - Urban

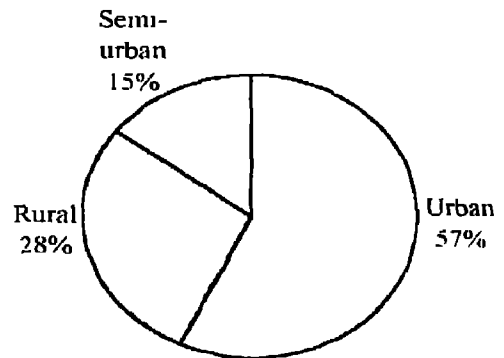


Fig. : II Father's Occupation

Service	101
Agriculture	15
Self-employed	31
Others	4

Fig. II Father's Occupation

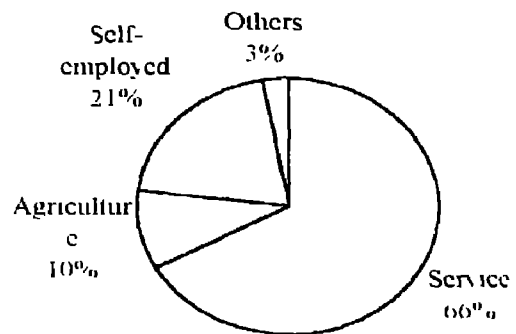


Fig. : III Who generated the idea

Teacher	111
Self	6
Parents	24
Others	2

Fig. . III Who Generated the Idea

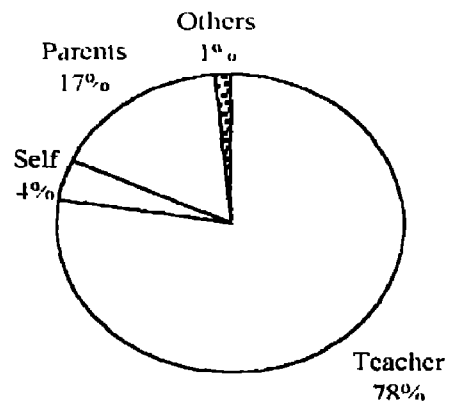


Fig. : IV Who Guided

Teacher	131
Parents	23
Self	13
Others	15

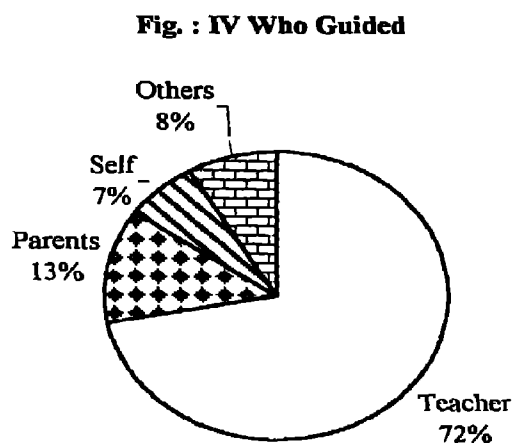


Fig. : V Time to prepare the Model

Up to 1 month	122
1 to 3 months	42
Above 3 months	5

Fig.V : Time to prepare the Model

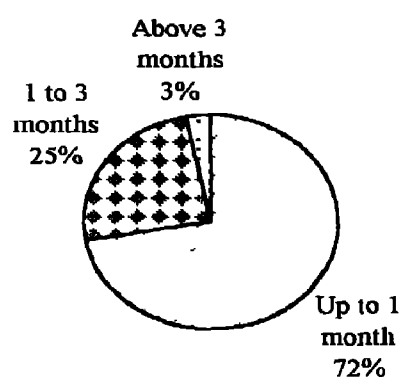


Fig.: VI Previous Record of Participation in Science Exhibition

Yes	169
No	6

Fig. VI : Previous Record of Participation in Science Exhibitions

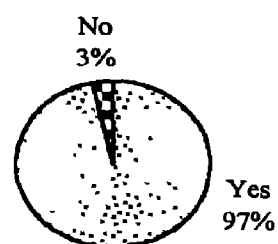


Fig.: VII Reading Science Journals

Yes	147
No	28

Fig. VII : Reading Science Journals

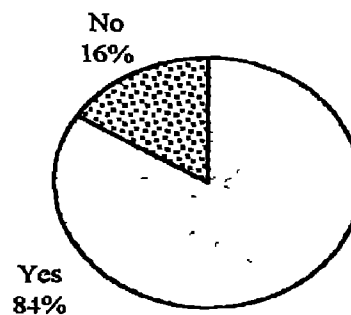


Fig. VIII: Listening Radio Programme

Yes	85
No	90

Fig. VIII : Listening Radio Programme

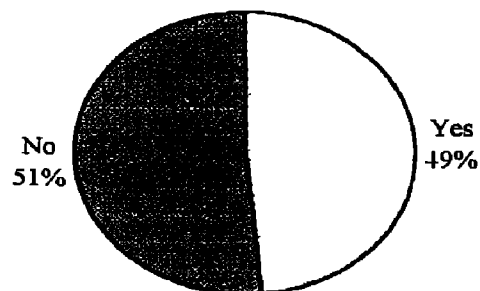


Fig.IX: Viewing TV

Yes	147
No	28

Fig.IX: Viewing TV

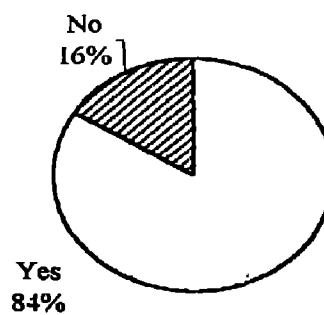


Fig. X: Total problems requiring Technological Interventions

Mentioned	64
Not mentioned	103

Fig. X: Local problems requiring Technological Interventions

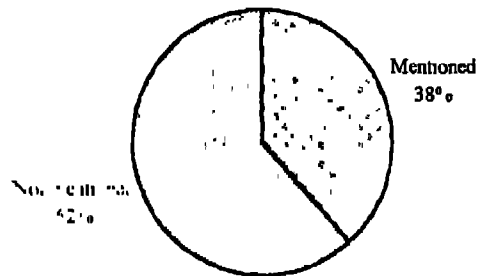
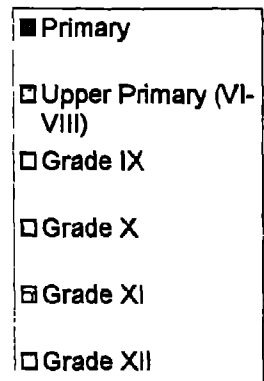
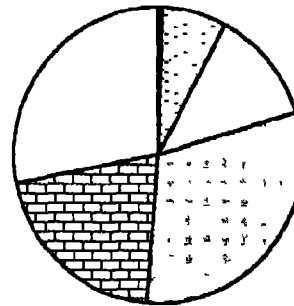


Fig XI:- School Levels of Participants

Primary	1
Upper Primary (V)	12
Grade IX	21
Grade X	52
Grade XI	34
Grade XII	47



B. Survey on accompanying teachers

Fig. I: Sex

Fig. I: Sex

Male	115
Female	46

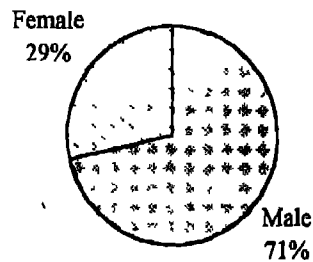


Fig. II : Stream

Science	131
Mathematics	10
Non-Science	15

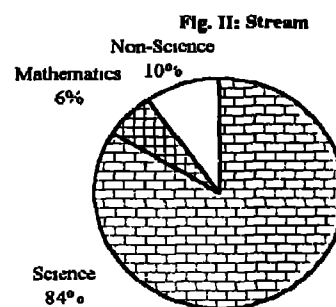


Fig. III: Teaching Experience

Above 10 years	110
Below 10 years	46

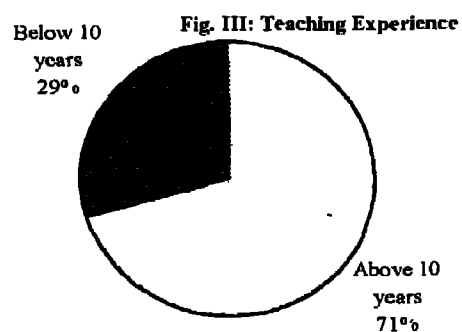


Fig. IV: Reading S&T Journals

Yes	42
No	121

Fig. IV: Reading S&T Journals

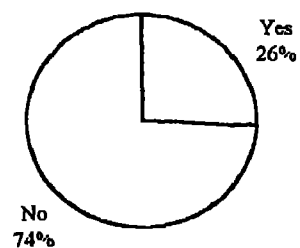


Fig. V: Visit to Science Museums/centres with students

Yes	103
No	60

Fig V: Visit to Science Museums/centres with students

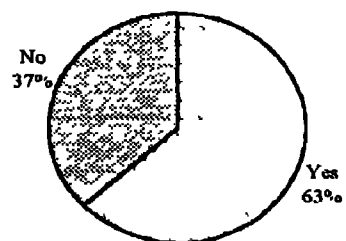
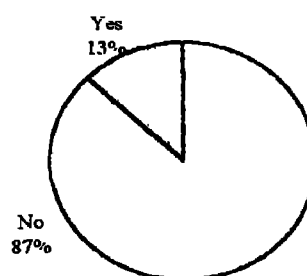


Fig. VI: Science club facilities in school

No	142
Yes	21

Fig. VI: Science club facilities in school



1.7 Awareness of children about problems in their immediate environment

- ❑ Deforestation at a fast rate, water purification system needs to be developed, traffic system, awful, acute shortage of power (Bhubneshwar)
- ❑ Purification of drinking water, irrigation, check dam, communication through cyber café (Silvassa)
- ❑ Damaged roads, feeble electricity and water supply (Indore)
- ❑ Deforestation at a fast rate, water purification system needs to be developed, traffic system, awful, acute shortage of power (Bhubneshwar)
- ❑ All locality has huge amount of garbages. It has to be disposed using proper scientific tools. (Trichy).
- ❑ Water problem in the institution (Keesara Gutta – A.P.)
- ❑ Cleaning of Septic tank which is otherwise done by hand. The people cleaning these tanks have to suffer from many diseases due to stench and dirt. (Verem – Goa)
- ❑ Water harvesting for uplifting water level, improve technology for damage roads need for generation of more electricity (indoor).
- ❑ To improve water supply by bore well and rain water harvesting Sajipa Moda (Karnataka)
- ❑ Checking the contamination water (Kondotty – Kerala)
- ❑ Sewage problem, pollution (Calicut).
- ❑ I live in metropolitan city the main problem is air pollution they have solved it by putting CNG buses, but still it is not under control (New Delhi).
- ❑ Water supply system as ours is in lands-slide area (Sikkim).
- ❑ Wastage of electricity at street lamps remain lamps remain on for a long time (Mysore).
- ❑ Load shading is a big problem. It happens mainly due to theft of current (Udaipur, Tripura)
- ❑ Conservation of energy, water scarcity, etc. (Gujarat)
- ❑ There is a big dam near our school. In the event of water reaching the danger limit or cracks in the dam wall information to people should reach upto 25 km (Ludhiana).
- ❑ Low voltage in electricity supply (A & N)
- ❑ The first problem in our area is pollution due to fluoride (Air & Water) by NALCO Smelter Plant. So the cattles are diseased. They can not work during farming. We the village people also feel pain in the joints of our body. No body takes care of us (Orissa).
- ❑ By giving previous information on flood, we can protect the lives of people in this area. By making pucca banks we can protect our crops (Begusarai – Bihar)
- ❑ Collection and disposal of household garbage. (New Delhi).
- ❑ The rural areas of our district should be educated first on different topics of agriculture, drug ediction and to keep the environment neat and clean (Vizianagaram – A.P.)
- ❑ The sewage released by nuclear fuel complex. (A.P.)
- ❑ Electricity problem (Bhimora – Gujarat).
- ❑ Frequent failure of electricity, non-availability of internet facility, ill-equipped science laboratories, water not being conserved properly (Kanjirapally – Kerala).

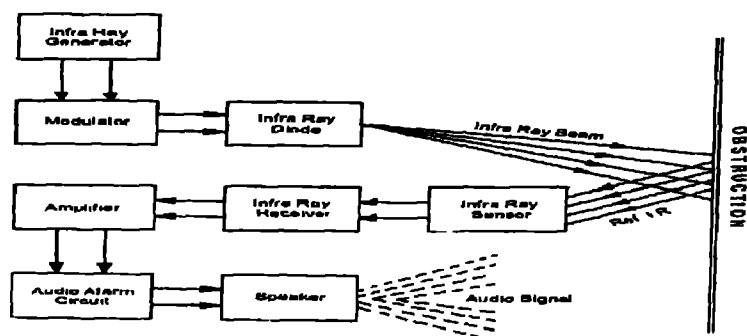
- ❑ We are not getting pure water. This problem can be solved by the constructing water purification industry (Tumkur – Karnataka).
- ❑ Electricity problem, inter net facility problem (Pulwama – J & K.).
- ❑ Plastic waste, unplanned sewage system (Pernam – Goa).
- ❑ A major problem yet to be solved in our locality is that of garbage disposal.
- ❑ The accumulation of household garbage and sewage, especially non-biodegradable wastes such as plastics can block the drainage system leading to water clogging. This in turn may lead to landslides or mudslides (Gangtok).
- ❑ Open dumping, plastics menace, sound pollution (Chandigarh).
- ❑ The problem in our locality is air pollution caused by vehicles, garbaging the open, lack of regular cleaning of road (Delhi).
- ❑ No food preservation method for the tribal people of our locality. (Kalahandi – Orissa).

2. Technological Innovations by children – 15 examples

Out of thousands of exhibits presented by the children during the last 30 years , shown below are 15 examples of technological innovations brought by them. All of them are working models exhibiting their zeal to identify problems, think of technological intervention to solve those, and then to fabricate models. They have come out with easy, intelligent, viable solutions to the problems of the blind, and the handicapped, technology to stop wastage of water, to equip the poor village craftsman with machines to speed up production, to recycle discarded plastics bags to manufacture tiles, to produce pollution-free vehicles, to motorize screw jacks ,to cool homes without power supply , to prevent air pollution from chimneys, to get compressed air for free ,to pump water from well using solar energy , and to save marine life from oil-spill.

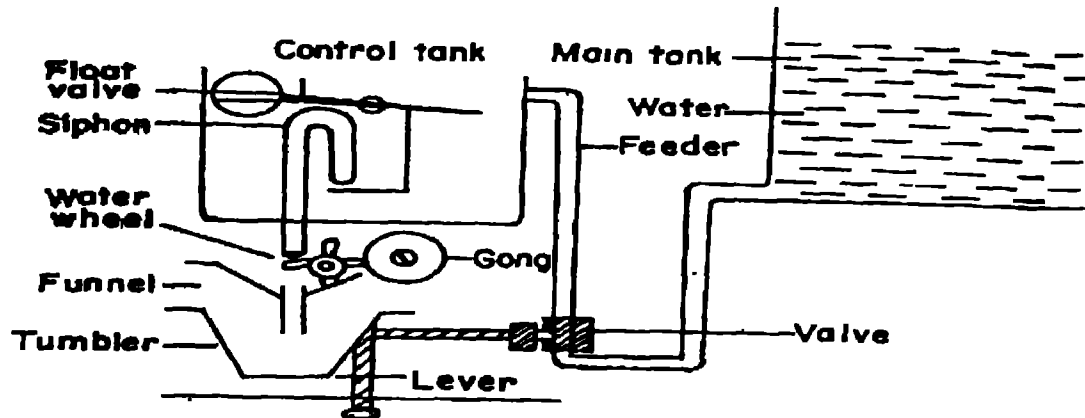
2.1 Infra-ray guide for the Blind

Infra ray generator along with a transmitter circuit and a receiver circuit with audio alarm has been shown in the Fig. The ray from infra ray diode is reflected from any nearby obstruction within the range of nearly 1.5 m ahead of the blind. The reflected infra ray is received by an infra ray sensor, which is amplified and which triggers an audio alarm circuit resulting in a radio signal from the speaker. The whole circuit and parts can be accommodated in a pencil box.



2.2 Liquid Dispenser for the Blind

One tumbler is placed in the position shown



in the diagram. The valve of the mains opens up through a lever. Then water flows to the control container. Water from the container flows to the tumbler through a siphon and a funnel. Before entering the funnel the water impinges on vanes of a wheel which make sound to alert the blind person that the water filling up the tumbler. Water fills the tumbler to a pre-determined quantity after which it stops flowing. Thus there is no wastage of water

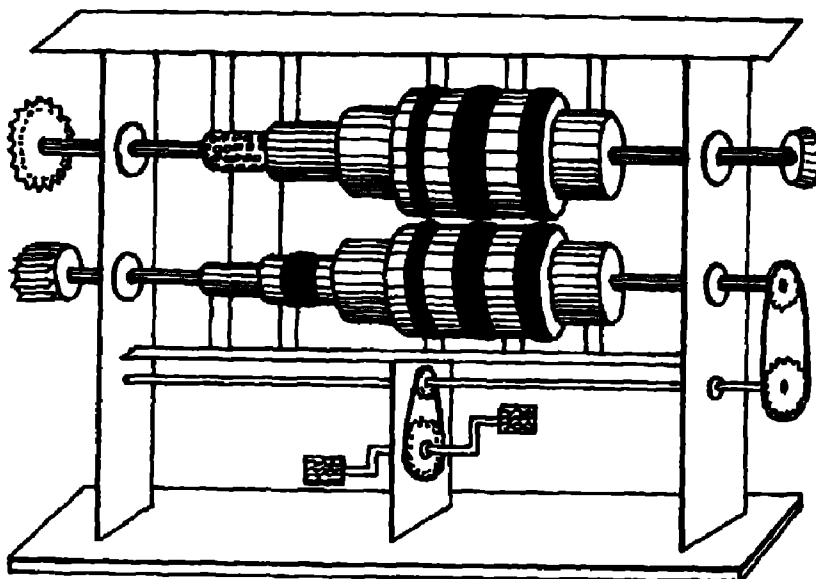
2.3 Spray Machine for use by the Handicapped

The handicapped without hands can water trees, spray pesticides on the fields and even can whitewash walls with the help of this machine. Two pump sets are constructed in the two soles of shoes. While walking the pumps are activated and water from the reservoir sprinkle through the nozzle as shown.

2.5 Device for Incising Bamboo Sticks and Canes

There are many families living around forests who depend on forest resources to earn their livelihood. Families producing incense sticks, baskets, and other bamboo products use their traditional tools which are not generally very productive. Shown below is a model of machine, which is an efficient labour saving device for incising bamboo and cane sticks to the desired shape and size for handcrafting bamboo products.

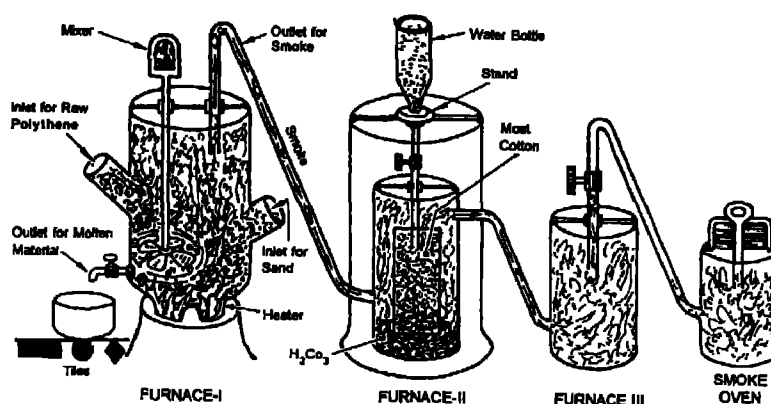
Two wooden rollers 10cm X 10cm have rubber sleeves of desired thickness so that bamboo reeds can easily pass through of the gap between rollers. A 15 cm long and 2 mm thick knife is set lengthwise on the left side so that it splits the bamboo stick into two equal parts. A 5 cm and 1 mm thick knife is fixed lengthwise on the right hand side, which further cuts the bamboo pieces to the size of incense sticks. The rollers in the machine are divided into 4 zones; the 15 cm long razor blade is set in between the rollers. Bamboo staff is sized to canes in the 1st zone. In the 2nd zone one can get bamboo canes that are used for house – fencing. At the left hand side a round saw is set to cut the bamboo sticks into small pieces. A 7.5 cm wooden wheel is fixed on the lower roller. On it 6 blades each 2.5 cm are fixed in such a manner so as to incise the bamboo reed into small sticks of the size of incense stick.



2.6 Raw Polythene Utilization Plant

Being non-biodegradable and the chief agent for clogging of water pipes and pollution, discarded polythene in the shape of bag and others products can be utilized for manufacturing useful products like tiles, carbonic acid (H_2CO_3) and fuel gas.

As shown in the diagram there are four furnaces out of which the first one has two inlets for sand and raw polythene. Polythene and sand are mixed into ratio of

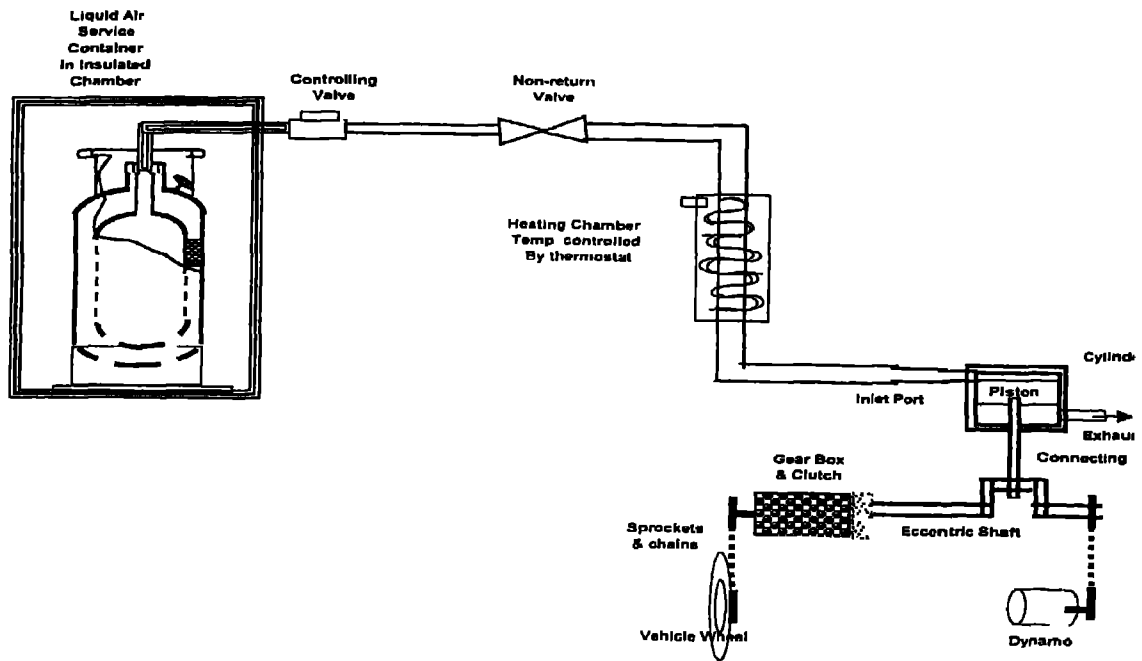


5 : 2 for making hard tiles at 500 K. Polythene melts, mixes with sand and thus low-cost tiles can be manufactured for use on footpaths etc. The smoke produced is converted into carbonic acid and fuel gas.

2.7 Pneumatic Car (Pollution free and Inexhaustible Source of Energy)

Inexhaustible and pollution free source of energy for automobiles is the cry of the day in order to save our environment as well as to conserve petroleum. In this model liquefied air has been used in place of petroleum for running engines. Liquefied air is to be obtained in cylinder (in the same way we obtain cooking gas in steel cylinders). As shown in the diagram the cylinder is connected to the engine through controlling valve, non-return valve heating chamber and inlet port. The piston in the engine is driven by the high pressure of air and reciprocating motion of the piston is converted into rotation at the axle through connecting rod and crank.

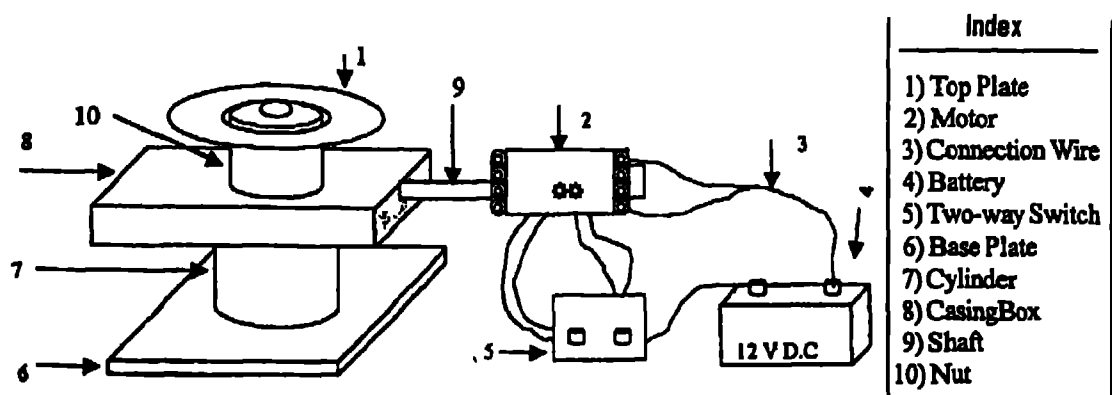
This can also be used in generating power.



2.8 Motor Jack

The conventional screw jack for lifting the vehicle for replacing the punctured tyre requires muscular effort. The motor jack shown in the diagram not only eliminates muscular efforts but saves time also.

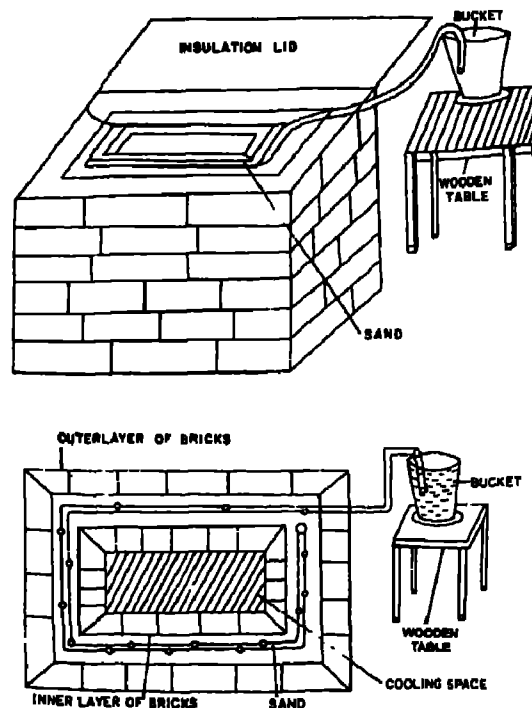
The motor Jacks takes electricity from the car battery. The speed of the motor at 1200 RPM is reduced to 15 RPM through worm/worm wheel. Due to the rotation of the worm wheel a screw moves up linearly as the machine nut is rotated by the worm wheel.. The jack can raise the load of



500 kg. up to a height of 13 cm from the ground in 25 seconds. The motor can be reversed when the job is complete.

2.9 Cheap Refrigerator

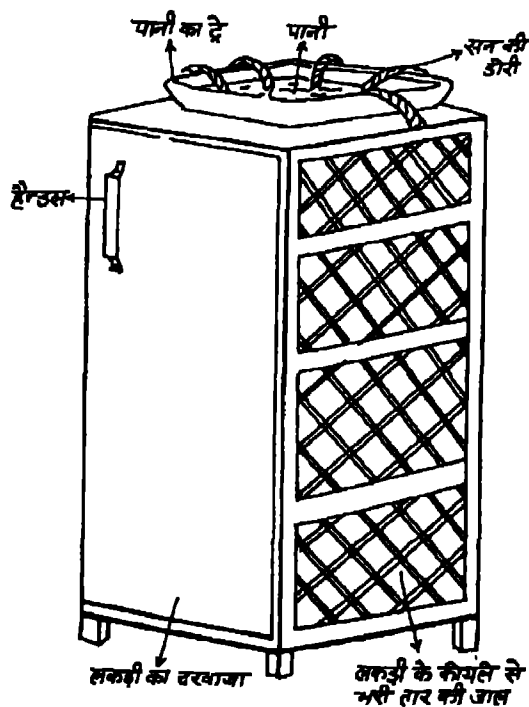
This model does not require electricity and covered space. It works on evaporation and associated heat transfer. As shown in the diagram, the construction requires 140 bricks, insulation sheets, two trays, two bags of sand, 5 m long plastic pipe, plastic bucket, stand and thermometers. There should be a gap of 60 mm between the outer and inner layers of bricks. This gap is to be filled by sand on which water will drip from the perforated plastic pipes.



2.10 Refrigerator without Electricity

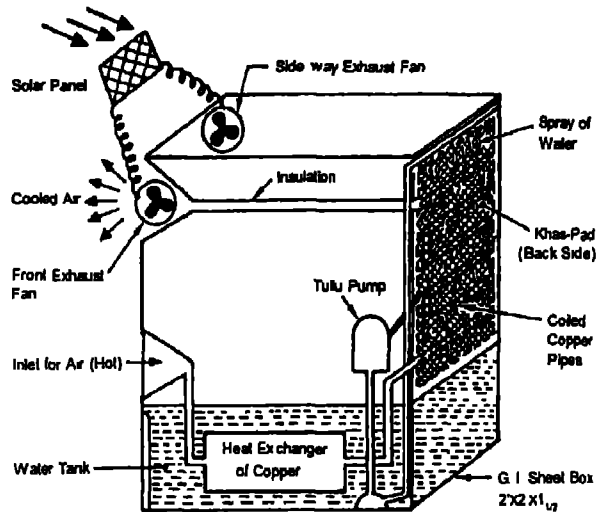
The refrigerator of the dimension 50 cm x 50 cm x 1 m has a frame of wood. Its door and shelves are made of plywood. Its three walls are made of aggregates of charcoal (each roughly 35 mm long) which are stacked loosely between two layers of wire mesh. A vessel containing water is kept on the roof of the refrigerator and cotton ropes dipped in the water siphon water, which through the charcoal on the three walls. 15 to 20 ropes are required for keeping the stack of charcoal pieces drenched.

As the water from the porous charcoal pieces evaporate (surface being very large) there is appreciable cooling effect inside the refrigerator.



2.11 Solar Desert AC Model

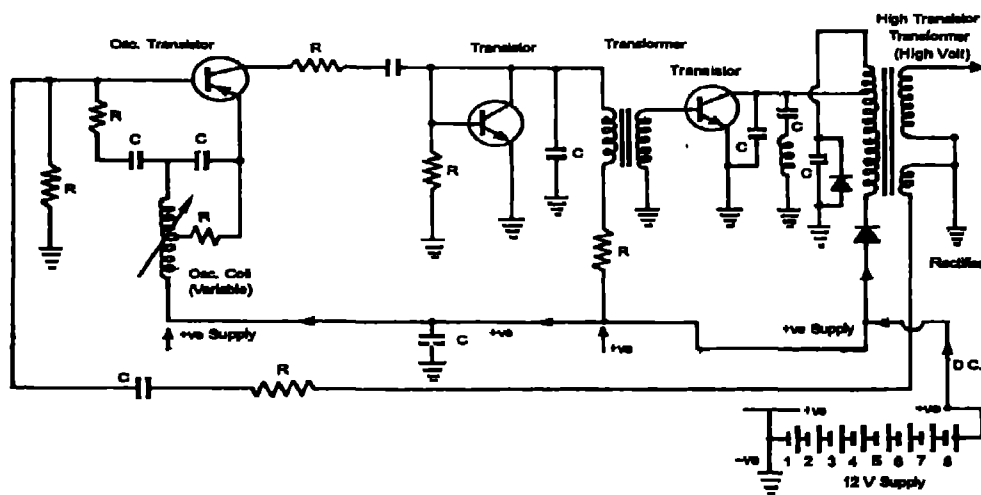
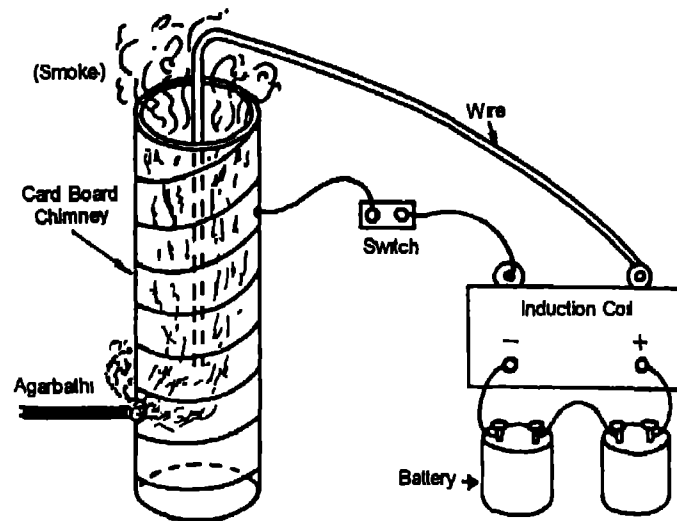
As shown in the diagram only one khas pad is



used resulting in saving of water. As this model will consume low power, it can easily be operated by a solar panel. The heat of incoming air is utilized in further evaporation of water. The power consumption of this model will be $1/10^{\text{th}}$ of the power consumed by an Air conditioner and water consumed by this model will be $1/4$ of the same by an ordinary desert cooler. The front side has two openings – the lower one as inlet of fresh air and the upper one for supplying cool air. The fan blowing cool air sucks the hot air of the room through the lower slot, heat exchanger, coiled section of the pad. Hot air of the room is thus cooled while passing through the water in the tank and further cooled while passing through the coiled pipes in the khas section. There is another exhaust fan on the side of the cooler to drive away humid air.

2.12 Electrostatic Precipitator

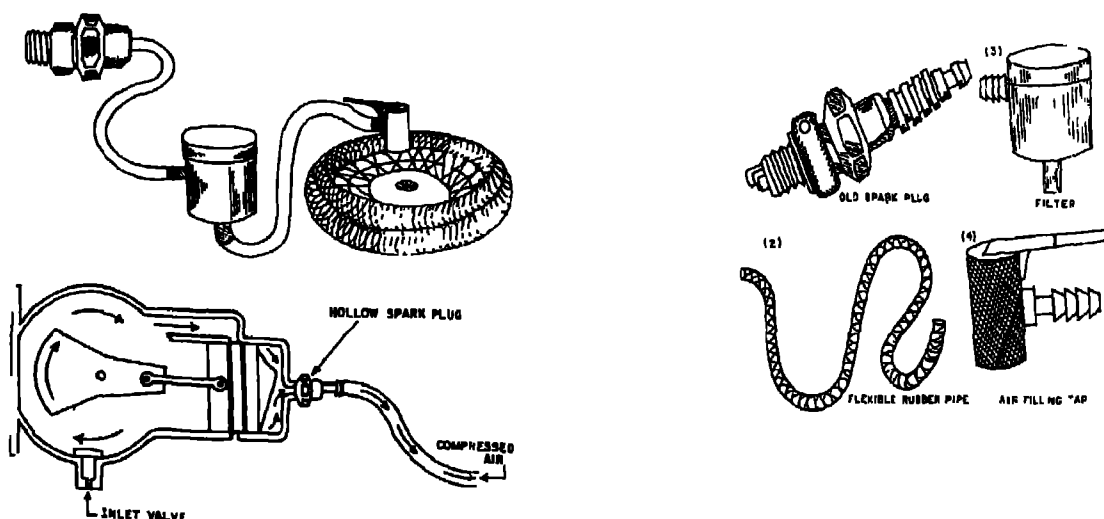
In this model the cardboard has an inner lining of 25 cm aluminum foil which is connected to the negative terminal of the induction coil. The positive terminal of the coil is connected to a thick wire passing through the centre of the tube (without touching the tube). 10,000 volt from the induction coil is applied to the tube as shown in the diagram. Particles in the smoke of the chimney get charged and stick to the walls of the chimney and thus pollution is prevented..



2.13 Spark Plug as an Air Filling Device

This is an improvised use of the compressed air in the cylinder of a scooter or motorcycle. A discarded spark plug of a two-wheeler is taken. Its ceramic body and central electrode is removed and its metallic socket is made free. Rubber pipe is inserted in the socket and air-filling valve is attached at the other end of the pipe via a filter. All the joints are made leakproof with the help of seals like M-seal ,etc.

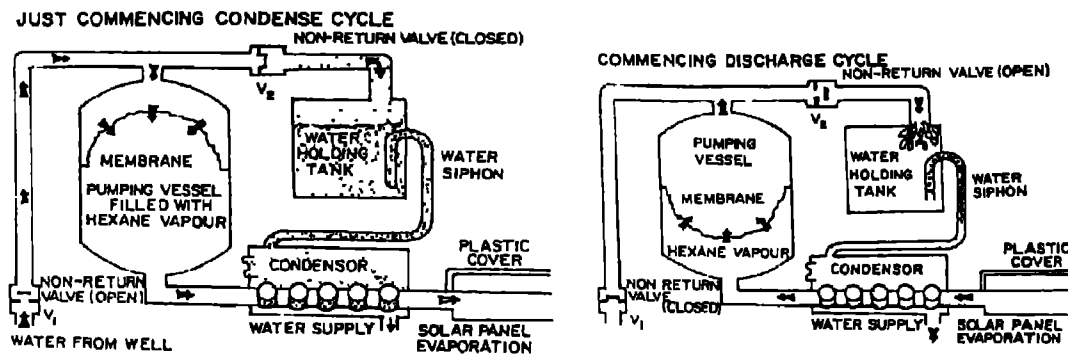
This improvised device is fitted to the engine of a motorcycle or scooter (the improvised spark plug is threaded in the cylinder head). The petrol cock of the vehicle is closed and the engine is run to burn out residual petrol in the cylinder. The spark plug of the engine is replaced by the improvised spark plug. Now if the engine is cranked by kicking, highly compressed air will be available during the compression and exhaust strokes. 15 to 20 kicks are required to inflate a tube with tyre with recommended pressure for scooties, scooters and motorcycles. The cost of the improvised device is nearly Rs.30/- .The same device can be used for spray painting and other purposes where compressed air is necessary.



2.14 Hexane Pump

A solar panel 2m^2 covered with plastic sheet contains hexane, the boiling point of which is around 68°C . As hexane evaporates it enters a closed chamber having special membrane which swells up and push out water in the pipe to the tank as shown in the diagram. After

doing work, the vapour loses heat and flows back through the condenser coils and becomes liquid again. During this phase the membrane comes down creating the vacuum for the inlet water pipe through which water rushes up through a non-return valve. The cycle is repeated. The system can be used to pump 1000 gallons of water a day from a depth of nearly 8 meters under average tropical conditions.

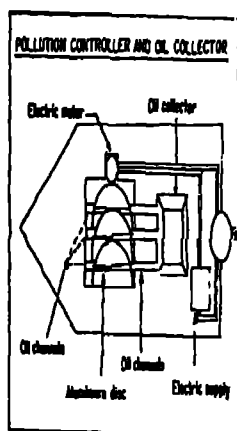


2.15 Pollution Controller and Fuel Collector

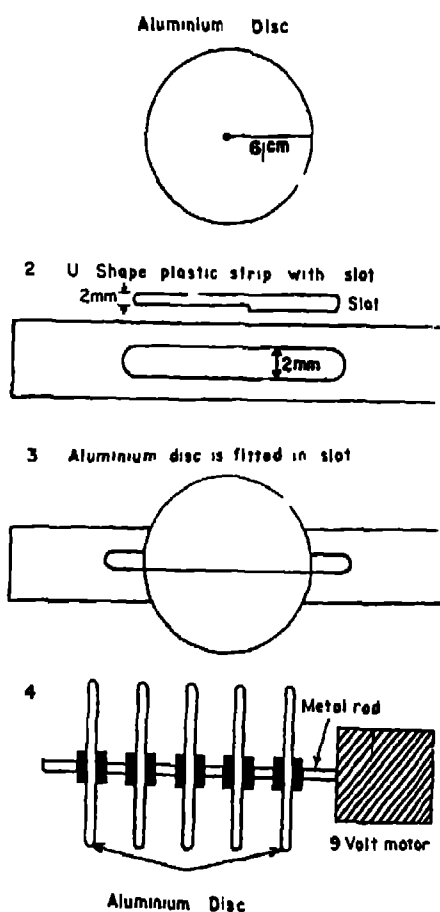
There have been many instances of major oils spill on the oceans. Such spills pollute the ocean by killing fish, birds and destroying the entire food chain and ecology. The model

shown in the diagram is one efficient method of retrieving the oil from the water .This works on the principle of surface tension. Surface tension of crude petroleum is nearly 40% of that of water at 20⁰C. The angle of attack between petroleum and aluminum (metal) is very favourable so far adhering of maximum quantity of oil to metal is concerned.

As shown in the diagram series of aluminium discs are rotated by motors, half of the disc remains dipped. As the motor rotates, oil sticking to the discs is retrieved as the disc is fitted with U-shaped strip to collect the oil from the surface of the disc. The collected oil flows to a tank .



(a)



(b)

3.The past and future of Science and Technology

3.1 Science and Technology in twentieth century

Science invention and discoveries are important because they lead to the creation of mechanisms and artifacts which improve or ease our living conditions. They come about sometimes by accident but mostly by design. The 20th century will be a memorable one for invention and discoveries world over. Much more is promised in the 21st century. Most of the discoveries in 20th century were the results of purposeful investigations and experiments, though some like penicillin were discovered accidentally. Inventions today are tied to industrial methods and production. An invention doesn't come into common use until it has been mass-produced and fitted with standardized, interchangeable parts. A distinguishing feature of 20th century research is the fact that it represents systematized inventions. It is largely devoted to technological research, discoveries and innovations.

Computers have revolutionized the way our modern society works and lives. They have touched every frontier of our life and work. Each day new kind of software is entering the market ; life is becoming easier and easier. Internet has made it possible to access all information under the Sun sitting at home. Anything is just one click away. E- education, e-governance, e-commerce, are gradually creeping in our society and we are gradually realizing their importance and benefits. We shall discuss some important inventions and discoveries of the 20th century, year wise,

1900's

-By 1900 Acharya J.C.Bose invented -millimeter wave optics, radio waves, - that most delicate and universal sign of life lay in the *electric* response of living things to stimulation, -response phenomena in plants lie intermediate between those in metals and in animals , and many instruments in electrophysiology.

1901 - Austrian Physician Karl Landsteines showed that there are at least three types of human blood – A ,B and O. These distinctions make blood transfusions possible. He also discovered Rh factor.

1902 - Scottish cardiologist James Mackenzie invented "Lie Detector".

1902 - Robert Bosch invented "Spark Plug".

1902 - Willis H. Carrier patented the 1st air conditioner

1903 - Marie Curie shared Nobel prize for Physics with Henri Becquerel and her husband Pierre for their discovery of "Radioactivity". She won 2nd Nobel prize in Chemistry in 1911 for isolating radioactive element Radium.

1904 - First "Geothermal Power Station" was built in Italy.

1904 - Glenn H. Curtiss built 1st engine intended specially for use in air-craft.

1905 - German chemist Walther Nernst explained why absolute Zero (273°C) can never be reached. This became the "3rd Law of Thermodynamics."

1906 - British biochemist Frederick Hopkins postulated that "Accessory Food Factors" are required for human health, these are now known as "Vitamins".

1907 - Belgian - American chemist Leo Bakeland patented "Bakelite"

1908 - Hans Geiger invented a machine that "translates Invisible Nuclear Radiation into audible clicks".

1909 - R.D. Carmichael introduced composite number that were pseudoprimes for every base called "Carmichael Number"

1910's

1910 - S.Z. Ferranti introduced parabolic "Mirror Reflector" for directional electric heating.

1911 - Ernst Rutherford, Hans Geiger and Ernest Marsden discovered the "Structure of Atom."

1913 - Irving Langmuir and Gaede invented "Mercury Diffusion Pump" for the production of high vacuum.

1914 - 1st modern sewage plant, designed to treat sewage with bacteria opened in Manchester, England.

1916 - Albert Einstein published his "General Theory of Relativity."

1917 - US astronomer George Hale built a "100 inch Reflecting Telescope"- the world's largest in California's Mount Wilson.

1918 - American astrologer Harlon Shapley described size and structure of "Milky Way Galaxy."

1919 - British physicist Ernest Rutherford artificially split an atom.

1920's

1921 - Canadian physician Frederick Banting and colleagues found "Treatment of diabetes."

1921 - Maxime Guillaume independently invented the principle of "Jet Engine".

1924 - French physicist Louis de Broglie described his theory that all matters behave as both particle and wave, just as light does

1926 - USA physicist Robert Goodard conducted the first successful launch of a "Liquid-Fuelled Rocket."

1927 - Werner Heisenberg described the "Uncertainty Principle."

1927 - Belgian astronomer and priest Georges Lemaitre proposed that universe began with a "Big Bang."

1927 - The President of American Telephone and Telegraph Co. picked up a telephone receiver in Manhattan. He talked to the Secretary of G.P.O. at Great Britain in London on January 17, 1927. This was the first telephone call in human history.

1928 - Scottish bacteriologist Alexander Fleming discovered "Penicillin."

1928 - Hungarian born biochemist Albert Szent Gyorgyi isolated "Vitamin-C"

1929 - US astronomer Edwin Hubble provided evidence that "universe is expanding".

1930's

1930 - US astronomer Clyde Tombaugh discovered "Pluto", the ninth planet.

1930 - Frank Whittle patented the "Jet Engine."

1933-35 - Teams in Germany and Britain independently invented "Radar". It helped in tracking air flight and surveillance.

1934 - French physicist Irene and Frederic Joliot Curie artificially induced "Radioactivity".

1934 - Visual study of genes was taken up by Dr. Calvin Blackman Bridges of Carnegie Institute.

1935 - US seismologist Charles Richter developed a scale for measuring the strength of earthquakes.

1936 - Hoover Dam on Colorado river was completed, creating the world's largest man-made reservoir Lake Mead.

1938 - After analyzing decades of temperature readings, British engineer George Cailender described what is later known as "green house effect".

1939 - First flight by a jet aircraft, built by German's Ernst Heinkel.

1939 - Swiss chemist Paul Mueller determined DDT as a powerful insecticide.

1940's

1940 - A sensational product of 1930s, was Du Pont's "Nylon", an artificial silk billed as a formidable rival to natural Japanese silk.

1942 - A team headed by Italian physicist Enrico Fermi produced the first "nuclear chain reaction".

1942 - Germany successfully launched the V-2, a surface-to-surface missile developed with the help of rocket scientist Wernher Von Braun.

1944 - In Mexico, American plant pathologist Norman Burlaug started developing high-yield grains that, two decades later, fuelled the green revolution.

1944 - Harvard University unveiled the world's greatest mathematical calculating machine. It solved in 19 hrs. problem that took four operators three weeks on ordinary office calculators.

1945 - US pilots cruising at high altitude discovered powerful west-to-east wind systems, later called Jet Streams

1945 - US Planes dropped atom bombs on Japanese cities; Hiroshima and Nagasaki. The atomic bomb destroyed about 5 square miles of city. Between 70,000 to 100,000 people are estimated to have been killed by the bomb. Other people died later from the effects of atomic radiation.

1946 - John Mauchly and John Eckert unveiled ENIAC (Electronic Numerical Integrator and Calculator), the first fully electronic computer. It was the first generation computer based on vacuum tube technology and could store twenty 10 digit numbers.

1947 - American Edwin Land invented "Polaroid Camera".

1947 - A research team at Bell Laboratories led by William Shockley, John Bardeen and Walter Brattain invented "Transistor".

1947 - US chemist Willard Libby developed "Radiocarbon Dating". which can determine the age of organic materials like wood and bone.

1950's

1952 - British physician Douglas Bevis described amniocentesis, a prenatal test for genetic abnormalities.

1952 - The First "Sex - Change Operation" was performed on a patient named George Jorgenson, later known as Christine Jorgenson.

1953 - James Watson and Francis Crick announced that they had deciphered the structure of DNA.

1954 - US endocrinologists Gregory Pincus, John Rock and C.R. Garcia developed the birth control pill.

1954 - The first "Atomic Power Station (5MW)" was established at Obninsk, 88 km, from Moscow.

1954 - Bell telephone laboratories produced a solar cell for direct conversion of sunlight into electricity.

1957 - Soviets send first artificial satellite, Sputnik, into orbit around earth.

1958 - Electrical engineer Wilson Greatbatch invented first cardiac pacemaker.

1960's

1960 - US physicist Theodore Maiman built a working laser.

1960 - The US Navy's bathyscaphe Trieste reached the bottom of Mariana Trench, which is believed to be deepest place in world. In Pacific Ocean's bottom they saw living creatures at the depth of 11 52 km, 2 74 km. deeper than Mount Everest.

1961 - The world's first spaceship Vostok (East), with Yuri Gagarin on board, was launched on April 12, 1961 in Soviet Union on a round-the-world orbit. The spaceship flew at a height of 300 km. and a speed of 28,800 km/h.

1964 - US surgeon Michael De Bakey performed the first successful coronary artery bypass operation.

1964 - A US surgeon first warned that smoking can be hazardous to human health.

1967 - South African surgeon Christian Barnard performed first successful "Human Heart Transplant", his patient Louis Washkansky, survived 18 days.

1967 - A J. Majumdar introduced Glass Reinforced Concrete

1969 - American astronaut Neil Armstrong walked on the moon surface. They carried rock samples from moon and helped scientists at ground station to take pictures.

1970's

1970 - US biochemist Linus Pauling touted Vitamin-C as a cure for everything from cancer to common cold

1971 - British engineer Godfrey Hounsfield invented the computerized tomography scanner (CAT-SCAN), which builds a 3-D image of brain.

1972 - US bans DDT because of its adverse effects on the environment

1975 - Scientists discovered a natural opiate, now known as endorphin (endogenous morphine) in brain.

1978 - Louis Brow, first test tube baby is born in England

1978 - To protect Earth's Ozone Layer, US bans Chlorofluorocarbons, which are used as propellants

1980's

1980 - WHO declared that smallpox has been eradicated. It was a scourge which had inflicted millions of people world wide.

1982 - Doctors in Los Angeles alerted the Centre for Disease Control to 5 cases of Pneumocystis Carini pneumonia, one of the earliest signs of AIDS (Acquired Immuno Deficiency Syndrome) epidemic. It is the last stage of infection with HIV.

1985 - Robert Galle of US National Cancer Institute and Luc Montagnier of France's institute, each published the genetic sequence of AIDS virus.

1986 - French and American oceanographers find Titanic, the then biggest ship in the world at a depth of nearly 13,000 ft. in the Atlantic. Titanic sank in Atlantic Ocean after hitting an iceberg. It was a prestigious ship of 19th century. Many rescue operations were undertaken earlier, but all drew a blank.

1990's

1991 - Tourist hiking in the Tyrolean Alps, discovered frozen dried remains of a man protruding from a glacier, who died about 3300 B C. Later the remains were brought and were kept for research.

1993 - Researchers at George Washington University cloned human embryos and nurtured them in vitro for several days.

1994 - Comet Shoemaker - Levy 9 crashed into planet Jupiter

1994 - Channel Tunnel connecting Britain and France was completed. The first regular passenger train service was introduced between London & Paris in November, and covered the distance in three hours

1997 - Scottish researcher's cloned a sheep named Dolly from cells on an adult ewe

Strong ethical questions were raised all over Europe on future of cloning through genetic microbiology and its impact on society. The objective for developing the technique was to clone transgenic animals for large scale production of pharmaceuticals. Even before the announcement of birth of cloned Dolly,

researchers had created a transgenic cow whose milk contained all amino acids a new born baby needs and might be used as a substitute for breast milk. After Dolly, Polly was cloned carrying human genes

1997 - A computer called Deep Blue beats world chess champion Gary Kasparov in a six- game match.

1997 - NASA's sojourner space craft roamed on surface of Mars and sends pictures back to earth.

2000's

2000 -The coding error could cause computers around the world to malfunction. Preventive measures were taken world wide to face any eventuality. If one successfully escapes the bug, it will be a happy and cheerful beginning to the 21st Century

3.2 Unimaginable Science and Technology to come to change this civilization in next 50 years

Our knowledge bank is growing exponentially ; it is doubling every three years. By the time a seven year old of today becomes seventy , the knowledge bank will double 21 times , that means, it will be multiplied nearly by a factor of one million.

The evolution of biological life and the evolution of technology have both followed the same pattern. We are entering the explosive part of the technological evolution graph. Gordon Moore ,co-founder of Intel, said that the processing power of computer doubles itself every 18 months (Moore' Law). We have seen the truth in it when we have already switched over to Pentium 4 today from 286 processor in early 90s. It is projected that by 2019 transistor features will be just a few atoms in width. Today computing cubes, another innovation, have thousands of layers of circuits and not just one as in today's computer chips. There fore, there is an exponential growth in computing. Other up-coming technologies include nanotube circuits, optical computing, crystalline computing, molecular computing, DNA computing. It will be possible to send nanobots (microscopic robots) into blood stream and programme them to explore every capillary, monitoring the brains intricate connections and neuro transmitter concentration

Humanoid Robots will emulate and have life- like facial expression are already being developed at several laboratories in Japan.

Bionics often refers to the replacement of living parts with cybernetic spare ones , but broadly it also means innovating better artificial system through biological principles. Merger of biological with micro-electronics is at he heart of most of the coming events. The power of gene and that of electron will be unleashed fully to transform fundamental facets of our lives.

Within about 50 years from now , we might see

- **A computer which will have the processing power of all human brains on earth**
- **A cloned human being.** A sheep named Dolly was cloned at the Rosline Institute near Edinburgh in February 1997 from the Udder cells of an ewe. A technology called somatic cell nuclear transfer was used.
- **An artificial womb for women**
- **Retinal Implant** will make it possible for a blind person to see
- **Replacement of hearts and livers** by custom grown ones from recipient's own stem cell.
- **Virtual reality** will come alive by addition of senses of smell and touch.
- **Custom clothing** from high resolution scans of buyer's body at a very low cost.
- **Production of food** that will counteract ailments like diabetes, cholera, high cholesterol, hepatitis.
- Growing bigger and harder muscles with **genetic vaccine** without sweating it out at the gym.

Research on the basic processes of cell differentiation holds out the promise of new medical interventions and cures. Burn victims might be provided **replacement skin** grown from their own body cells. Those with spinal chord injuries will have similar replacement ; damage by degenerative disorders like diabetes, Parkinson's disease or Alzheimer's disease might be reversed.

As the advancement speeds up and order increases exponentially, the returns accelerate at a nonlinear rate. It is projected that **by 2019 , an 1000- dollar PC will have the processing power of the human brain** i.e. 20 million billion calculation per second. According to Neuroscientists, each of 100 billion neurons in the human brain has 1000 connections and each connection does 200 calculations per second.

4. Frontier Science and Cutting Edge Technology in India ----Children must know

This chapter will bring insight into the prudent challenges for technological interventions for wealth generation and social transformation in India. This will enable students to take part in discussion leading to problem solving and decision making. They will also get ample project ideas as well as India's Science and Technology Policy (2003)

PROSPEROUS HAPPY AND SECURE SOCIETIES

Technology Development



Wealth Generation



Social Transformation



Universal Harmony & Development

Can Space technology be a main tool?

4.1 Deliberations in the 90th Indian Science Congress

The 90th session of Indian Science Congress was held in Bangalore during January 3-7, 2003. In the presence of the galaxy of top scientists of India, NASA, ESA, NOAA, Chinese National Space Agency, Hon'ble President of India delivered a lecture "Space Mission for Earth Problems". Hon'ble Prime Minister of India unveiled the Science and Technology Policy of India. Hon'ble Minister for HRD delivered a lecture "Science for Society". The general President of the Congress and Chairman of ISRO Dr. K. Kasturirangan spoke of the need to evolve cutting edge technologies that are people-centric and environment friendly.

Excerpts from the President's lecture which concern school children most and which will inspire them most to pursue science and technology are reproduced here

Hon'ble Dr Kalam, the President of India who is also a top technologist spoke highly of the progress of space Science and Technology world over. He said that India has plans for moon mission and reusable launch vehicles

During the last century the world has undergone a change from agriculture society, where manual labour was the critical factor, to industrial society where the management of technology, capital and labour provided the competitive advantage. Then the information era was born, last decade, where connectivity and software products are driving the economy of a few nations. In the 21st century, a new society is emerging where knowledge is the primary production resource instead of capital, and labour. Efficient utilisation of this existing knowledge can create comprehensive wealth and also improve the quality of life - in the form of better health, education, infrastructure, and other social indicators. Ability to create and maintain the knowledge infrastructure, develop knowledge workers and enhance their productivity through creation, growth and exploitation of new knowledge will be the key factors in deciding the prosperity of this knowledge society. As we progress from one society to another, we have been doing value addition to the processes followed in the previous societies. Info-space technology can do tremendous value addition in the way we have been doing agriculture, industry, education, health care etc.

The societal transformation has to be through large scale development in education, healthcare, agriculture and governance. These in turn will lead to employment generation, high productivity and rural prosperity. Core areas that will spearhead our march towards knowledge society are Space technology integrated with information and communication technology which include generation of conventional and non-conventional energy, environment & ecology protection, mining of new resources from planets, telemedicine & tele-education, infotainment. The era of wood and bio-mass is almost near its end. Fossil fuels will soon be depleted and India with 28% of World's population and 0.4% of world's oil and gas reserves will have to bear the brunt of the impending crisis. Massive burning of remaining reserves of coal would surely lead the world in ecological disaster. Nuclear power especially a breakthrough in nuclear fusion may be a path. But sustainable economic development and perennial sources of clean which would then heal the wounded planet earth's environment and ecology in the only massive use of the solar energy.

Twenty thousand children of the world are dying everyday due to polluted drinking water, this figure is more than the total mortality due to cancer, AIDS, wars and accidents. By 2025 when world population touches 8 billion, as many as seven billion will be living

under conditions of moderate, high and extreme water scarcity. There is a four-fold path towards safe, fresh drinking water. The first is to redistribute water supply, the second is to seek new sources, the third is to save and reduce demand for water, and the fourth is to recycle used water supply.

Space science and technology can surely find sustainable regional solutions for abundant and perennial supply of fresh drinking water. In our country, redistribution of water supply through networking of rivers is now being taken up as a critical mission. Remote sensing to survey and evolve optimum water routes, environmental mapping and afforestation requirements, and continuous monitoring of the networked water flow through all seasons and at all times may require a dedicated satellite constellation for our networked river systems.

Seeking new water supply sources may also be yet another thrust area for space science and technologies. Reverse osmosis technologies for sea water desalination in new energy efficient manner is rapidly evolving.

Space based solar power stations have six to fifteen times greater capital utilization than equivalent sized ground solar stations. Linking Space solar power to reverse osmosis technology for large-scale drinking water supplies to coastal cities is thus yet another major contribution which could be made by space technologies for sustainable economic development through regional solutions for the impending drinking water crisis.

Can Space technology provide solutions to these fundamental problems of man and society? Surely, it has already begun to do so. The social values added and enhanced social productivity is largely due to satellite imagery for land and water management. It is also due to satellite based e-education and connectivity to community activities for sustainable economic development. But, this is just a beginning and the tip of the iceberg.

It is only international cooperation that can yield shared benefits beyond expendable launch vehicles and space-craft for information missions in the areas of tele-communications and imagery. Solutions to the Man-Planet conflict for energy, water and mineral resources may be discovered in a new 21st century Space era of low cost access to space with re-usable launch vehicles. The geostationary orbit is nearly full, and new earth orbit need study and exploration especially use of small satellites in equatorial low earth orbit. Currently global space industry has a capacity to launch over 200 tonnes of satellites every year.

Further expansion of man's activities in Space can and must take place only in a global cooperative manner that will integrate all nations' Space capabilities to reduce Man-Planet

conflict patterns. This calls for reduction of low cost of access to space by several orders of magnitude to enable the global space community move out of the era of information missions into an era of mass missions and find solutions for energy, water, and mineral crises which is soon to engulf mankind.

Though India was a late comer in the modern space activities, it is one of the five nations today placed its own satellite using indigenous GSLV.

India is already working to evolve innovative design concepts for both small as well as large payloads into space. Both single and two-stage to orbit RLV concepts are being examined. The goal here is to reduce the cost of access to Space by one and two orders of magnitude. Even a small scientific breakthrough, for example, in air breathing propulsion systems may lead to a Space transportation revolution. The World Space community has a huge stake in such breakthrough research in advanced inter-disciplinary and inter-institutional collaboration. A global effort is thus needed to quickly demonstrate at least on a small scale the technology for low cost access to Space.

The Space Summit may therefore, have a long term 50 year perspective from small scale technology demonstrations of re-usable launch vehicles through small solar power satellite demonstrations and small satellite constellations to heavy lift RLVs for large scale solar power satellites, space manufacturing and ultimately to space colonization and extra terrestrial mining.

It would thus be seen that space technology is central to and enjoys special links with major aspects socio-economic development. This includes information technology, infrastructure including electric power, education and health-care, agriculture and agro food processing, strategic industries and geo-strategic initiatives. All this is bound to lead to rapid economic growth and a high level social security.

SOCIETAL TRANSFORMATION

PROBLEMS FACING THE SOCIETY

- * **POVERTY**
- * **ILLITERACY**
- * **UNEMPLOYMENT**
- * **DEPLETION OF ENERGY SOURCES**
- * **DRINKING WATER SHORTAGES**
- * **POLLUTION AND ENVIRONMENT PROTECTION**

POSSIBLE SOLUTION OFFERED BY SPACE TECHNOLOGY

- * **SATELLITE IMAGES FOR LAND AND WATER MANGEMENT**
- * **E-EDUCATION AND CONNECTIVITY**
- * **COMMUNITY DEVELOPMENT**
- * **EMPLOYMENT CREATION**
- * **SOLAR POWER SATELLITE Harvesting Energy from Space**
- * **NUCLEAR WASTE DISPOSAL IN OUTER SPACE**
- * **EXTRA TERRESTRIAL MINING**

4.2 Keywords, Key phrases, Key Sentences:

Basic research is pacemaker of technological improvement, technological development often leads to new Science and vice-versa, our 'genetic software' Cutting edge technology for sustainable consumption and climate change mitigation, nanotechnology springs from convergence of advances in condensed matter physics, engineering, molecular biology and chemistry and deals with materials or systems with at least one dimension of about 1 to 101 nanometer, nanotechnology to increase efficiency of converting energy to light, improve quality of medical diagnostics, to develop nano-tags and imaging systems, digital divide, technology that completely eliminate waste

Knowledge products of information and communication , technology, bio-technology and info-space technology, technology park, space programme

Science and Technology Policy (STP-2003) , India with six major scientific departments, 400 national R&D laboratories, 231 Universities, and about 1300 in-house R & D units in industry represents one of the world's largest systems for generation of creative Science and Technology

Tenth Plan, Target of 8% GDP growth rate, agricultural science, production of pulses, oil seeds, vegetables, animal husbandry, dairying, fisheries, horticulture, medicinal plants, energy plants, agro-processing industries, IT, IT exports could match a mark of 50 billion US dollars Wastage in farm produce, new employment opportunities, basic healthcare, generation of new vaccines, accurate low-cost diagnostic kits, protection from dangerous infections

Three kinds of technologies in India - modern, conventional and traditional, environmental protection, land and water conservation, modern environmental norms, global warming, water scarcity, deforestation, unprecedented concentration of green house gases, strain on natural resources of earth, globalisation, advanced energy technology, annual average per capita commercial energy consumption in India is about 500 kg of oil equivalent (low in comparison to global average), alternate energy sources such as fuel cells, micro electric generators, nuclear, wind and energy sources, nuclear energy systems, non-conventional and renewable energy, cleaner use of fossil fuels, urban transport management system, climate and weather system, disaster prevention and management, to launch satellite into geostationary orbit with our own launch vehicles, ocean observation capabilities, harnessing vast energy sources in the ocean, CSIR was granted 100th US patent in 2002, National Innovation Foundation set up two and a half years ago has started championing the cause of grass root innovation, be they slum dwellers, artisans, school drop outs, illiterate, farmers and so on, talent should not be suppressed and individualism should not replace teamwork; internal brain drain - we need to examine why a career in Science is not considered worthwhile by so many of our talented younger scientists, attracting the Indian Scientific diasporas, scientific education, Indian Science award of Rs 25 lakhs to be given each year Unveiling of sequence of human genome, ability to splice genetic material, transfer genes, cell fusion technology, bio process technology, bioengineering on crops, microbes, plants and animals, genome mapping of plants and animals, transgenic crops, disease resistance capabilities, nitrogen fixation, prevention of enzymes and recombinant proteins

Can you interpret the following phrases from S.T.S point of view?

1 Ecological soundness 2 low energy inputs, 3 Use of renewable and recyclable materials, 4. Craft industry orientation 5 integration with nature, 6 democratic politics, 7 decentralisation 8. emphasis on agricultural diversity 9 Community control 10. multi-disciplinarity. 11. Science and Technology not dependent on the specialist elite but performed by all

S-T-S means Science-Technology-society

ANNEXURE

SCIENCE AND TECHNOLOGY POLICY- 2003

(--Source DST)

“ we must take science to the people All of us are fond of quoting Pandit Jawaharlal Nehru’s famous words paying a tribute to your community – namely, that ‘Scientists are a minority in league with the future’ This is true But let us also remember that a bright future can be realized only when science is in league with the majority of our society ”

- Shri Atal Bihari Vajpayee
Prime Minister of India

“Our new policy is anchored in our abiding belief that for science and technology to grow, it must be green, it must be ethical, it must have a human face, it must be gender sensitive, it must be region and context-specific, reflect our enormous diversity and plurality, and it must empower the community as a whole and not merely a section of it ”

- Dr. Murli Manohar Joshi
Minister for Human Resource Development, Science & Technology and Ocean Development

“The Science & Technology Policy 2003 provides a road map for integrating science and technology directly with societal concerns ”

- Shri Bachi Singh Rawat
Minister of State for Science & Technology

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A - PREAMBLE

Science and technology have profoundly influenced the course of human civilization. Science has provided us remarkable insights into the world we live in. The scientific revolutions of the 20th century have led to many technologies, which promise to herald wholly new eras in many fields. As we stand today at the beginning of a new century, we have to ensure fullest use of these developments for the well being of our people.

Science and technology have been an integral part of Indian civilization and culture over the past several millennia. Few are aware that India was the fountainhead of important foundational scientific developments and approaches. These cover many great scientific discoveries and technological achievements in mathematics, astronomy,

architecture, chemistry, metallurgy, medicine, natural philosophy and other areas. A great deal of this traveled outwards from India. Equally, India also assimilated scientific ideas and techniques from elsewhere, with open-mindedness and a rational attitude characteristic of a scientific ethos. India's traditions have been founded on the principles of universal harmony, respect for all creation and an integrated holistic approach. This background is likely to provide valuable insights for future scientific advances. During the century prior to Independence, there was an awakening of modern science in India through the efforts of a number of outstanding scientists. They were responsible for great scientific advances of the highest international caliber.

In the half century since Independence, India has been committed to the task of promoting the spread of science. The key role of technology as an important element of national development is also well recognised. The Scientific Policy Resolution of 1958 and the Technology Policy Statement of 1983 enunciated the principles on which the growth of science and technology in India has been based.

Over the past several decades, these policies have emphasized self-reliance, as also sustainable and equitable development. They embody a vision and strategy that are applicable today, and would continue to inspire us in our endeavors.

With the encouragement and support that has been provided, there is today a sound infrastructural base for science and technology. These include research laboratories, higher educational institutions and highly skilled human resource. Indian capabilities in science and technology cover an impressive range of diverse disciplines, areas of competence and of applications. India's strength in basic research is recognized internationally. Successes in agriculture, health care, chemicals and pharmaceuticals, nuclear energy, astronomy and astrophysics, space technology and applications, defense research, biotechnology, electronics, information technology and oceanography are widely acknowledged. Major national achievements include very significant increase in food production, eradication or control of several diseases and increased life expectancy of our citizens.

While these developments have been highly satisfying, one is also aware of the dramatic changes that have taken place, and continue to do so, in the practice of science, in technology development, and their relationships with, and impact on, society.

Particularly striking is the rapidity with which science and technology is moving ahead. Science is becoming increasingly inter- and multi-disciplinary, and calls for multi-institutional and, in several cases, multi-country participation. Major experimental

facilities, even in several areas of basic research, require very large material, human and intellectual resources. Science and technology have become so closely intertwined, and so reinforce each other that, to be effective, any policy needs to view them together. The continuing revolutions in the field of information and communication technology have had profound impact on the manner and speed with which scientific information becomes available, and scientific interactions take place

Science and technology have had unprecedented impact on economic growth and social development. Knowledge has become a source of economic might and power. This has led to increased restrictions on sharing of knowledge, to new norms of intellectual property rights, and to global trade and technology control regimes. Scientific and technological developments today also have deep ethical, legal and social implications. There are deep concerns in society about these. The ongoing globalisation and the intensely competitive environment have a significant impact on the production and services sectors.

Because of all this, our science and technology system has to be infused with new vitality if it is to play a decisive and beneficial role in advancing the well being of all sections of our society. The nation continues to be firm in its resolve to support science and technology in all its facets. It recognizes its central role in raising the quality of life of the people of the country, particularly of the disadvantaged sections of society, in creating wealth for all, in making India globally competitive, in utilizing natural resources in a sustainable manner, in protecting the environment and ensuring national security.

B - POLICY OBJECTIVES

Recognizing the changing context of the scientific enterprise, and to meet present national needs in the new era of globalisation, Government enunciates the following objectives of its Science and Technology Policy

- To ensure that the message of science reaches every citizen of India, man and woman, young and old, so that we advance scientific temper, emerge as a progressive and enlightened society, and make it possible for all our people to participate fully in the development of science and technology and its application for human welfare. Indeed, science and technology will be fully integrated with all spheres of national activity.
- To ensure food, agricultural, nutritional, environmental, water, health and energy security of the people on a sustainable basis.
- To mount a direct and sustained effort on the alleviation of poverty, enhancing livelihood security, removal of hunger and malnutrition, reduction of drudgery and

regional imbalances, both rural and urban, and generation of employment, by using scientific and technological capabilities along with our traditional knowledge pool. This will call for the generation and screening of all relevant technologies, their widespread dissemination through networking and support for the vast unorganized sector of our economy.

- To vigorously foster scientific research in universities and other academic, scientific and engineering institutions, and attract the brightest young persons to careers in science and technology, by conveying a sense of excitement concerning the advancing frontiers, and by creating suitable employment opportunities for them. Also to build and maintain centres of excellence, which will raise the level of work in selected areas to the highest international standards.
- To promote the empowerment of women in all science and technology activities and ensure their full and equal participation.
- To provide necessary autonomy and freedom of functioning for all academic and R&D institutions so that an ambience for truly creative work is encouraged, while ensuring at the same time that the science and technology enterprise in the country is fully committed to its social responsibilities and commitments.
- To use the full potential of modern science and technology to protect, preserve, evaluate, update, add value to, and utilize the extensive knowledge acquired over the long civilizational experience of India.
- To accomplish national strategic and security-related objectives, by using the latest advances in science and technology.
- To encourage research and innovation in areas of relevance for the economy and society, particularly by promoting close and productive interaction between private and public institutions in science and technology. Sectors such as agriculture (particularly soil and water management, human and animal nutrition, fisheries), water, health, education, industry, energy including renewable energy, communication and transportation would be accorded highest priority. Key leverage technologies such as information technology, biotechnology and materials science and technology would be given special importance.
- To substantially strengthen enabling mechanisms that relate to technology development, evaluation, absorption and upgradation from concept to utilization.
- To establish an Intellectual Property Rights (IPR) regime which maximises the incentives for the generation and protection of intellectual property by all types of inventors. The regime would also provide a strong, supportive and comprehensive policy environment for speedy and effective domestic commercialisation of such inventions so as to be maximal in the public interest.
- To ensure, in an era in which information is key to the development of science and technology, that all efforts are made to have high-speed access to information, both in quality and quantity, at affordable costs, and also create digitized, valid and usable content of Indian origin.
- To encourage research and application for forecasting, prevention and mitigation of natural hazards, particularly, floods, cyclones, earthquakes, drought and landslides.
- To promote international science and technology cooperation towards achieving the goals of national development and security, and make it a key element of our international relations.

- To integrate scientific knowledge with insights from other disciplines, and ensure fullest involvement of scientists and technologists in national governance so that the spirit and methods of scientific enquiry permeate deeply into all areas of public policy making

It is recognized that these objectives will be best realized by a dynamic and flexible Science and Technology Policy, which can readily adapt to the rapidly changing world order. This Policy, reiterates India's commitment to participate as an equal and vigorous global player in generating and harnessing advances in science and technology for the benefit of all humankind.

C - STRATEGY AND IMPLEMENTATION PLAN

Keeping in view these broad objectives, it is essential to spell out an implementation strategy that will enable identification of specific plans, programmes and projects, with clearly defined tasks, estimates of necessary resources, and time targets. Some of the key elements of the implementation strategy will be as follows: -

1. Science and Technology Governance and Investments

Suitable mechanism will be evolved by which independent inputs on science and technology policy and planning are obtained on a continuous basis from a wide cross section of scientists and technologists. It will utilize the academies and specialized professional bodies for this purpose. These inputs will form an integral part of the planning and implementation of all programmes relating to science and technology, as also in government decision making and formulation of policies in socio-economic sectors.

A greater integration of the programmes in socio-economic sectors with R&D activities will go a long way in ensuring a wider, more visible and tangible impact. This will call for a certain percentage of the overall allocation of each of the socio-economic ministries to be devoted for relevant programmes and activities in science and technology. The States will also be encouraged and assisted in the use of science and technology for developmental purposes through mechanisms set up for this, and in establishing linkages with national institutions for solving their regional and locale-specific problems.

A concerted strategy is necessary to infuse a new sense of dynamism in our science and technology institutions. The science departments, agencies and other academic institutions, including universities i.e. the science and technology system

as a whole, would be substantially strengthened, given full autonomy and flexibility, and de-bureaucratized

Mechanisms will be established to review on a continuous basis the academic and administrative structures and procedures in the science and technology system at all levels, so that reforms could be effected to meet the challenges of the changing needs.

It will be ensured that all highly science-based Ministries/Departments of Government are run by scientists and technologists. All the major socio-economic Ministries will have high-level scientific advisory mechanisms

Government will ensure continued existence of an Apex S&T Advisory Body which will assist in formulating and implementing various programmes and policies. It will have appropriate representation of industry leaders, leading scientists and technologists and various scientific departments

Government will make necessary budgetary commitments for higher education and science and technology. It will, through its own resources and also through contribution by industry, raise the level of investment to at least 2% of GDP on science and technology by the end of the Tenth Plan. For this, it is essential for industry to steeply increase its investments in R&D. This will enable it to be competitive, achieve greater self-reliance and self-confidence, and fulfill national goals

2. Optimal Utilization of Existing Infrastructure and Competence

Science and technology is advancing at a very fast pace, and obsolescence of physical infrastructure, as also of skills and competence, take place rapidly. Steps will be taken to network the existing infrastructure, investments and intellectual strengths, wherever they exist, to achieve effective and optimal utilization, and constantly upgrade them to meet changing needs

3. Strengthening of the Infrastructure for Science and Technology in Academic Institutions

A major initiative to modernize the infrastructure for science and engineering in academic institutions will be undertaken. It will be ensured that all middle and high schools, vocational and other colleges will have appropriately sized science laboratories. Science, engineering and medical departments in academic institutions and universities and colleges will be selected for special support to raise the standard of teaching and research. To begin with, a significant number of academic institutions, specially the universities, as also engineering and medical institutions,

would be selected for this support to make an impact Flexible mechanisms for induction of new faculty in key areas of science would be developed Constancy of support and attention will be ensured over at least a ten-year period

4. New Funding Mechanisms for Basic Research

The setting up of more efficient funding mechanisms will be examined, either by creating new structures or by strengthening or restructuring the existing ones, for promotion of basic research in science, medical and engineering institutions In particular, administrative and financial procedures will be simplified to permit efficient operation of research programmes in diverse institutions across the country

Creation of world class facilities in carefully selected and nationally relevant fields will be undertaken, to enhance our international competitiveness in areas where we have strengths, opportunities or natural advantages Indigenous expertise will be used to the maximum extent possible This would help in nurturing high quality talent and expertise in experimental science and engineering

5. Human Resource Development

The number of scientists and technologists, while being large in absolute numbers, is not commensurate with the requirements in quality and when measured on a per capita basis The demand is bound to increase in the coming years with more intensive activities involving science and technology There is need to progressively increase the rate of generation of high quality skilled human resource at all levels This process would naturally entail reversing the present flow of talent away from science, by initiating new and innovative schemes to attract and nurture young talent with an aptitude for research, and by providing assured career opportunities in academia, industry, Government or other sectors *In order to encourage quality and productivity in science and technology, mobility of scientists and technologists between industry, academic institutions and research laboratories will be ensured*

For building up the human resource base in relevant areas, the agencies and departments concerned with science and technology will make available substantial funding from their allocation Flexible mechanisms will be put in place in academic and research institutions to enable researchers to change fields and bring new inputs into traditional disciplines, and also to develop inter-disciplinary areas There will be emphasis on a continuing process of retraining and reskilling to keep pace with

the rapid advances taking place. Wherever considered necessary, training abroad will be resorted to, so as to build up a skilled base rapidly.

Women constitute almost half the population of the country. They must be provided significantly greater opportunities for higher education and skills that are needed to take up R&D as a career. For this, new procedures, and flexibility in rules and regulations, will be introduced to meet their special needs.

New mechanisms would be instituted to facilitate the return of scientists and technologists of Indian origin to India, as also their networking, to contribute to Indian science and technology.

Schemes for continuing education and training of university and college teachers in contemporary research techniques and in emerging areas of science will be strengthened and new innovative programmes started.

It will also be ensured that higher education is available to the widest possible section of creative students, transcending social and economic barriers.

6. Technology Development, Transfer and Diffusion

A strong base of science and engineering research provides a crucial foundation for a vibrant programme of technology development. Priority will be placed on the development of technologies which address the basic needs of the population, make Indian industries — small, medium or large — globally competitive, make the country economically strong, and address the security concerns of the nation. Special emphasis will be placed on equity in development, so that the benefits of technological growth reach the majority of the population, particularly the disadvantaged sections, leading to an improved quality of life for every citizen of the country. These aspects require technology foresight, which involves not only forecasting and assessment of technologies but also their social, economic and environmental consequences.

The growth rate in productivity of the Indian economy has been below its true potential, and the contribution to it of technological factors is inadequate. Similarly, Indian exports today derive their comparative advantage through resource and labour rather than through the power of technological innovation. The transformation of new ideas into commercial successes is of vital importance to the nation's ability to achieve high economic growth and global competitiveness. Accordingly, special emphasis will be given not only to R&D and the technological factors of innovation, but also to the other equally important social, institutional and

market factors needed for adoption, diffusion and transfer of innovation to the productive sectors

Intensive efforts will be launched to develop innovative technologies of a breakthrough nature, and to increase our share of high-tech products. Aggressive international bench-marking will be carried out. Simultaneously, efforts will be made to strengthen traditional industry so as to meet the new requirements of competition through the use of appropriate science and technology. This industry is particularly important as it provides employment at lower per capita investment, involves low energy inputs, and carries with it unique civilizational traditions and culture. Value addition, and creation of wealth through reassessment, redistribution and repositioning of our intellectual, capital and material resource will be achieved through effective use of science and technology.

Deriving value from technology-led exports and export of technologies will be facilitated through new policy initiatives, incentives and legislation. This will include intensive networking of capabilities and facilities within the country.

Rigid Quality Standards, and Accreditation of testing and calibration laboratories according to international requirements, will be given an enhanced push to enable Indian industry to avoid non-tariff barriers in global trade.

A comprehensive and well-orchestrated programme relating to education, R&D and training in all aspects of technology management will be launched. To begin with, Indian Institutes of Management (IIMs), Indian Institutes of Technology (IITs) and other selected institutions will be encouraged to initiate these programmes.

7. Promotion of Innovation

Innovation will be supported in all its aspects. A comprehensive national system of innovation will be created covering science and technology as also legal, financial and other related aspects. There is need to change the ways in which society and economy performs, if innovation has to fructify.

8. Industry and Scientific R&D

Every effort will be made to achieve synergy between industry and scientific research. Autonomous Technology Transfer Organizations will be created as associate organizations of universities and national laboratories to facilitate transfer of the know-how generated to industry. Increased encouragement will be given, and

flexible mechanisms will be evolved to help, scientists and technologists to transfer the know-how generated by them to the industry and be a partner in receiving the financial returns. Industry will be encouraged to financially adopt or support educational and research institutions, fund courses of interest to them, create professional chairs etc. to help direct S&T endeavours towards tangible industrial goals.

There has to be increased investments by industry in R&D in its own interest to achieve global competitiveness to be efficient and relevant. Efforts by industry to carry out R&D, either in-house or through outsourcing, will be supported by fiscal and other measures. To increase their investments in R&D, innovative mechanisms will be evolved.

9. Indigenous Resources and Traditional Knowledge

Indigenous knowledge, based on our long and rich tradition, would be further developed and harnessed for the purpose of wealth and employment generation. Innovative systems to document, protect, evaluate and to learn from India's rich heritage of traditional knowledge of the natural resources of land, water and biodiversity will be strengthened and enlarged. Development of technologies that add value to India's indigenous resources and which provide holistic and optimal solutions that are suited to Indian social-cultural-economic ethos will be developed. A concerted plan to intensify research on traditional systems of medicine, so as to contribute to fundamental advances in health care, and leading to commercialisation of effective products will be undertaken, appropriate norms of validation and standardization will be enforced. A purposeful programme to enhance the Indian share of the global herbal product market will be initiated.

10. Technologies for Mitigation and Management of Natural Hazards

Science and technology has an important role in any general strategy to address the problems of mitigation and management of the impacts of natural hazards. A concerted action plan to enhance predictive capabilities and preparedness for meeting emergencies arising from floods, cyclones, earthquakes, drought, landslides and avalanches will be drawn up. Measures will be undertaken to promote research on natural phenomena that lead to disasters and human activities that aggravate them. This will be with a view to developing practical technological solutions for pre-disaster preparedness, and mitigation and management of post-disaster situations.

11. Generation and Management of Intellectual Property

Intellectual Property Rights (IPR), have to be viewed, not as a self-contained and distinct domain, but rather as an effective policy instrument that would be relevant to wide ranging socio-economic, technological and political concepts. The generation and fullest protection of competitive intellectual property from Indian R&D programmes will be encouraged and promoted.

The process of globalisation is leading to situations where the collective knowledge of societies normally used for common good is converted to proprietary knowledge for commercial profit of a few. Action will be taken to protect our indigenous knowledge systems, primarily through national policies, supplemented by supportive international action. For this purpose, IPR systems which specially protect scientific discoveries and technological innovations arising out of such traditional knowledge will be designed and effectively implemented.

Our legislation with regard to Patents, Copyrights and other forms of Intellectual Property will ensure that maximum incentives are provided for individual inventors, and to our scientific and technological community, to undertake large scale and rapid commercialization, at home and abroad.

The development of skills and competence to manage IPR and leveraging its influence will be given a major thrust. This is an area calling for significant technological insights and legal expertise and will be handled differently from the present, and with high priority.

12. Public Awareness of Science and Technology

There is growing need to enhance public awareness of the importance of science and technology in everyday life, and the directions where science and technology is taking us. People must be able to consider the implications of emerging science and technology options in areas which impinge directly upon their lives, including the ethical and moral, legal, social and economic aspects. In recent years, advances in biotechnology and information technology have dramatically increased public interest in technology options in wide ranging areas. Scientific work and policies arising from these have to be highly transparent and widely understood.

Support for wide dissemination of scientific knowledge, through the support of science museums, planetaria, botanical gardens and the like, will be enhanced. Every effort will be made to convey to the young the excitement in scientific and

technological advances and to instill scientific temper in the population at large. Special support will be provided for programmes that seek to popularize and promote science and technology in all parts of the country. Programmes will also be developed to promote learning and dissemination of science through the various national languages, to enable effective science communication at all levels.

A closer interaction of those involved in the natural sciences and technology, social sciences, humanities and other scholarly pursuits will be facilitated to bring about mutual reinforcement, added value and impact.

13. International Science and Technology Cooperation

Scientific research and technology development can benefit greatly by international cooperation and collaboration. Common goals can be effectively addressed by pooling both material and intellectual resources. International collaborative programmes, especially those contributing directly to our scientific development and security objectives, will be encouraged between academic institutions and national laboratories in India and their counterparts in all parts of the world, including participation in mega science projects as equal partners. Special emphasis will be placed on collaborations with other developing countries, and particularly neighbouring countries, with whom India shares many common problems. International collaboration in science and technology would be fully used to further national interests as an important component of foreign policy initiatives.

14. Fiscal Measures

Innovative fiscal measures are critical to ensure successful implementation of the policy objectives. New methods are required for incentivising R&D activities, particularly in industry. New strategies have to be formulated for attracting higher levels of public and private investments in scientific and technological development. A series of both tax and non-tax fiscal instruments have to be evolved to ensure a leap-frogging process of development. The formulation of a focused strategy and the designing of new methods and instruments requires inputs from economists, financial experts and management experts and scientists. For this purpose, the apex S&T advisory body will constitute a dedicated task-force to suggest appropriate fiscal measures to subserve the policy objectives.

15. Monitoring

Effective, expeditious, transparent and science-based monitoring and reviewing mechanisms will be significantly strengthened, and wherever not available will be put in place. It will be ensured that the scientific community is involved in, and responsible for, smooth and speedy implementation.

16. The New Vision

To build a new and resurgent India that continues to maintain its strong democratic and spiritual traditions, that remains secure not only militarily but also socially and economically, it is important to draw on the many unique civilizational qualities that define the inner strength of India; this has been intrinsically based on an integrated and holistic view of nature and of life. The Science and Technology Policy 2003 will be implemented so as to be in harmony with our world view of the larger human family all around. It will ensure that science and technology truly uplifts the Indian people and indeed all of humanity.